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Stage Scenery and Lighting

A Handbook for Non-Professionals

by

[illegible]

Technical Director Carolina Playmakers,
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and

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PREFACE

Our purpose in preparing this book is to satisfy a need for a short, but comprehensive and practical, handbook of scenery and lighting for college, school, and community theatres. It is addressed primarily to those who are designing, building, painting, and lighting scenery; but in it something of interest will be found for the director and actor, as well as for the student of the theatre.

The plan of the book is intended to make it useful in two ways. It is, first, a reference manual for the individual of some experience who wishes to find specific information on a particular problem. For this person the material is carefully arranged in major and minor divisions with a system of titles, sub-titles, and cross-references for convenience in finding needed information.

The book, in the second place, is a text for one with little or no experience who wishes to study the subject of scenery and lighting from the beginning. For this person the material is arranged under separate topics and chapters which present the subject step by step in a logical sequence. After an explanation of what scenery is, the reader is led to examine the topography of a stage, the elements of scenery, some common arrangements of these elements into stage settings, and some methods of planning settings by means of drawings and models. Then follows the study of the construction and painting of scenery and the assembling and shifting of the completed parts on the stage.

Part Two begins with a short statement of the functions and demands of stage lighting and follows with a brief review of electricity and light for those who have no technical background. After a survey of standard lighting equipment and its adaption to the needs of the Little Theatre, a general discussion of the use of light, shade, and color leads finally to the analysis of a definite light plot. New terms are defined along the way, and related or explanatory material is made easy to find by means of the cross-references.

The equipment and methods outlined in this book are essentially those employed in Broadway playhouses and scenic studios. Slight changes, however, are occasionally advised to adapt the "standard" methods and equipment to the special requirements of simplicity and economy peculiar to the Little Theatre.

We wish to acknowledge our indebtedness to: Prof. George P. Baker for the use of photographs of productions at the Department of Drama, Yale University Theatre; Prof. Frederick H. Koch for photographs of the Playmakers Theatre and of productions by the Carolina Playmakers, University of North Carolina; Mr. Lee Simonson and the Theatre Guild for photographs of Guild productions; *Theatre Arts Monthly* for permission to reproduce Mr. Robert Edmond Jones' sketch, "At the Gateway," from his book, *Drawings for the Theatre,* and another pen and ink sketch by Mr. Cleon Throckmorton; Mr. Peter Clark for a photograph and a blue print of two counterweight installations; Frank Adam Electric Co. for photographs of switchboards; Kliegl Bros., Universal Stage Lighting Co., Major Equipment Co., Century Lighting Co., and Ward-Leonard Electric Co. for photographs of lighting equipment.

We wish to express our appreciation for valuable suggestions

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We wish also to acknowledge our special indebtedness to Mr. J. Albert Bliss for his many criticisms and help in laying out Part I; and to the Extension Department, University of North Carolina, for permission to reprint large sections from the chapters on the construction and painting of scenery in its bulletin *Scenery and Lighting for School and Little Theatre Stages* by Samuel Selden.

S. S.
H. D. S.

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PART ONE

STAGE SCENERY

by

Samuel Selden

CHAPTER I

INTRODUCTION—THE DESIGN OF SCENERY

1. The Organic Theory of Play Presentation

The "art" of the theatre, as it is generally conceived, is made up of two parts—the writing of a play and the presenting of a play, both being related by a single creative design. An author has a vision, which he writes down. A group of fellow artists take his script and, by following the directions they find there, attempt to re-create his vision for an audience. They make his phantom idea visible and audible by translating it out of his mind into acting, music, dancing, costuming, scenery, and lighting. The same thought and spirit governs the re-created vision that governed the original—if the artists who have done the translating have understood the directions in the text and been intelligent in carrying them out.

Words in a text, however, are only symbols for thoughts, and it is often possible to interpret symbols in a number of different ways. Several artists of speech, pantomime, decoration, and lighting may read an author's directions for a presentation and from them make quite dissimilar translations. Because the essential thing in a vision is the idea and not the form, each of these artists, if he be a good interpreter, will in his way be right; if his translation alone is placed on the stage, an audience will feel and see in it a true re-creation. If several dissimilar translations are placed on the stage at the same time, however, there can be only confusion; the effect pro-

duced will be like that of the proverbial orchestra composed of many excellent musicians, but with no conductor. A re-created vision then, if it is to be understood, must be unified in all its members. In other words, the impression or effect a performance as a whole produces upon an audience must be one.

Herein lies the difference between the old and the new conception of the art of the theatre. A quarter of a century ago the art of the theatre was considered to be a composite thing, a large art made by bringing together, for the moment, a number of loosely related, independent, lesser arts. Sometimes the members of this group co-operated in a performance, but more often they competed against each other. Today the art of the theatre is better understood to be a single thing, a great art made out of a complete fusion of many lesser arts—acting, dancing, music, scenery, properties, costumes, and lighting—all carefully orchestrated before they are placed before an audience. They are designed for a "perfect co-ordination of emotional appeals." [1] The conductor of the projected dramatic symphony is the director.

2. The Element of Action in the Presentation

Play presentation, as we have said, is the business of re-creating an author's vision for his audience. Because the most important element of a vision is a moving spirit, the heart of the re-created vision is *action*. By action we do not mean purely physical pantomime and speech; we mean the spirit of acting, that vital flow or *dramatic movement* which, through the medium of rhythmic speech and gesture, impels a play on

[1] Sheldon Cheney: *Stage Decoration*, The John Day Company, New York, 1928.

the stage forward and makes it live and breathe. The art of the actor, who is the special instrument of action, becomes naturally, then, the central art of play presentation. All the other interpretative arts of the theatre—music, scenery, lighting, and the rest—must be conceived as complementary and contributive to this "first" art. Sheldon Cheney, among many other men of the theatre, has reached this conclusion in his recent book, *Stage Decoration*.[2] "Any working definition of the art of the theatre today," he declares, "has to emphasize the presentation of a play by actors on a stage, through a flow of action, *with that fusion of all the contributive stage arts which makes the drama live for its audience at its highest possible emotional intensity*. Within this larger definition there should be special emphasis on *action* as the essentially theatric core of the art; but either action in the sense of movement (as in early ritual drama and in the recently highly developed dance-dramas), or in the sense of the unfolding of a story or drama by actors using speech largely for expressiveness."

The study of scenery is then the study of one of those contributive arts that develop and enrich dramatic action.

But what does it contribute?

3. Scenery, the Environment of Action

What, exactly, must scenery do for action?

It will be possible to answer this question clearly only if it is decided at the start just what is meant by the term "scenery." The word in the theatre today is used to represent two things. Employed in a strictly technical sense it refers to painted cloths,

[2] See footnote on page 4.

screens and frames, and certain of their mechanical accessories —forms that stand for walls and skies and trees and platforms. Used in a broader sense it means what Gordon Craig calls *scene,* all those visual elements that surround an actor in his performance on the stage—furniture and incidental objects ("properties"), costumes and lighting, as well as the larger forms just mentioned. For the purpose of the study of scenery in relationship to play presentation let us in this chapter use the term in its larger sense.

If one searches the written thoughts of the great artists and critics of the new stagecraft for their answers to the question of what is the purpose of scenery for action, and through that for the play, one finds some interesting opinions. The most quotable ones are those given in the form of definitions. Scenery, or *scene,* says Gordon Craig, should be the visual expression of the dynamic spirit of a play "in all that comes before the eye." [3] Adolphe Appia feels that scenery, in its best sense, is the light and the plastic elements which by surrounding a living and active presence on the stage add to its vitality.[4] Lee Simonson has much the same view. Scenic art he believes to be "the creation of plastic forms and spaces that are an integral part of acting and project its meaning." [5] Scenery, declares Sheldon Cheney, must be "an adequate and appropriate background for theatric action." [6] Kenneth Macgowan offers a similar thought when he says that scenery should function as "an emotional envelope appropriate to the dramatic mood of the author, a visualization in color, line and light of the dominant emotions to be pictured

[3] Gordon Craig, *On the Art of the Theatre,* London, 1911—reprinted by Dodd, Mead, New York, 1925.

[4] Adolphe Appia *Musik und die Inscenierung,* Munich, 1899.

[5] *Theatre Arts Monthly,* June, 1924.

[6] Sheldon Cheney, *Stage Decoration,* The John Day Company, New York, 1928.

THE SERAGLIO PREPARED FOR TORTURE
A design by Cleon Throckmorton for *Princess Turandot.*

by the actors." [7] Robert Edmond Jones says simply that scenery should be an "environment" of action.

If one examines the array of august opinion here represented, one finds that through it all runs a single idea—an idea which is most clearly suggested, probably, by Mr. Jones' one word "environment." A definition of the purpose of scenery that is representative of the best expression in the theatre today might be this: *In the organic design of play presentation scenery should function as the visual environment of theatric action.* Because most artists think of action and acting, from the practicable standpoint of a performance, as being essentially the same thing, it may safely be concluded that it is the duty of scenery, through the use of suggestive and significant surrounding forms, to help the actor translate the thought and spirit of an author's vision in the most effective manner possible.

[7] Kenneth Macgowan, *The Theatre of Tomorrow,* Boni and Liveright, New York, 1921.

The conception of scenery as the environment of action is called "new," not because the first expression of it was made a short while ago, but because only recently has it had any wide acceptance in the theatre.[8] Little more than fifteen years ago the art of the stage designer was still commonly discussed in terms of "creating striking stage pictures" only. The artist then aimed at impressiveness rather than at appropriateness. Scenic art in the older period, Sheldon Cheney tells us, "was considered as a separate and independent rather than a contributive art, was seldom coördinated with the arts of the playwright, the actor and the costumer, and was glorified at the expense of the play and acting." [9] A British designer has left us, in a little book he wrote for amateurs as late as 1913, a very clear indication of what most of the theatre men in his day thought of scenery. After discussing the value of scenery in the production of a forceful impression of "reality," he describes the success of scenic art on some contemporary London stages:

"Perhaps the production at Drury Lane is a strong melodrama. What is most discussed in connection with that production? Almost always some big and novel effect, such as the representation of a race between aeroplanes or a battle between submarines. Again, in the case of a Shakespearean production at His Majesty's, the talk in the green-rooms and at the dinner-tables of London is often more of the scenic beauty of the production than of the achievement of the actors and actresses. And the talk of the 'man in the street' follows the same lines." [10]

The success or failure of "scenic beauty" at the time of this

[8] Adolphe Appia and Gordon Craig are usually credited with being the first to bring into clear focus and to give popular literary expression to the environmental idea of scenery.

[9] See footnote No. 6.

[10] Taken by permission from Van Dyke Browne's *Secrets of Scene Painting and Stage Effects,* published by E. P. Dutton and Co., Inc., New York.

writing was evidently measured directly by the amount of attention it could draw to itself. The artist's proud boast that the scenery he described in his book could so effectively enter into competition with an actor that the latter's finest efforts would be lost in his surroundings sounds very strange to us now. Very different from the attitude of this artist of a few years ago is that of a leading artist of today. Robert Edmond Jones has frequently declared that he is most content when his settings (he has created many beautiful ones) fit a performance so perfectly that they are not noticed. In a foreword to his *Drawings for the Theatre* [11] he says that a finished scene is one that will cause a spectator on the rise of the curtain to remark to himself not, What a magnificent picture!—but—"It is evident that this play we are about to see is no common play. It is evident that these men and women who will appear before us are no common mummers. These are Actors, Seers, Sayers. Let us honor them. For by their inspiration they intimate immortality."

4. The Functions of the Environment: Placing the Action

The argument outlined so far in these pages has attempted to prove that scenery must be the visual environment of action; but it has not yet put forth just how such an environment contributes, in the unfolding of a play, to the effectiveness of the action.

I believe that scenery as environment fulfills its duty to action in three principal ways.

Environment implies place. The first function of scenery, then, is to locate the action—to give it a home, so to speak. This

[11] Robert Edmond Jones, *Drawings for the Theatre*, Theatre Arts, New York, 1925.

it may do in one, or a combination, of about four different manners to suit the particular requirements of the play for which it is designed. A "realistic" setting, for instance, may be created to give a definite, life-like (though not necessarily a complete) portrayal of an actual or imaginary locality appropriate to the action—such as:

The parlor of Abraham Lincoln's house at Springfield, Illinois, early in 1860. (John Drinkwater's *Abraham Lincoln,* Scene I)

The Reception-Room of Mr. Latimer's house, a little off the Dover Road. (A. A. Milne's *The Dover Road,* Act I)

Such a scene builds up an illusion of place by making use of purely imitative forms—"real" walls, "real" doors and windows, "real" mouldings, furniture, and pictures. The artist who creates the setting attempts to make the spectator feel that he is gazing into the kind of sitting-room or garden that actual people, not merely characters in a play, might use. The realistic and semi-realistic plays of today and the near past—plays by such authors as Ibsen, Shaw, Galsworthy, Barry, Kelly, and Molnar —are usually presented in settings of this type. To produce an *effect* of reality an imitative scene does not have to be a complete portrayal of natural forms. An over-detailed, elaborate, photographic representation a good artist always avoids, because it tends to clutter the stage and interfere with the acting. All of the best of the realistic settings today are very simple, with many elements of the scene left to the imagination of the spectator.

Or, a scenic environment may be created to place the action "suggestively" by intimating a locality without fully describing it.

Another chamber (Shakespeare's *II King Henry IV,* Act IV, Scene V)

The scenery for this kind of a setting makes use of a few simple forms to stand for a complete picture—a Gothic bench and a chest in front of a tapestry to suggest a room in an early English castle, or a few simple shapes of tree trunks standing out of heavy shadows to hint at a forest. Each form in the setting is a symbol for a whole group of other forms called up in the mind of the man who looks at the picture. The spectator is made to *feel* the presence of that which is not actually shown. In the production of *Romeo and Juliet* in which Jane Cowl and Rollo Peters played a few years ago Capulet's house in the orchard was suggested by a plain little balcony placed in a single panel in the center of the stage. The rest of the set consisted merely of soft, dark, neutral draperies and an atmospheric arrangement of lighting. That was all, but as soon as Romeo spoke, the sense of place was complete. Many types of plays—most of the Shakespearian and romantic plays, those by Rostand, Dunsany, and Millay, certain historic plays, and even some realistic plays—are set very successfully in environments which are only suggested.

Again, the action may be placed "stylistically." In such a scene the emphasis is placed, not on the representation of natural forms, but on the expression of an idea. The artist, in designing the scene, makes use of a distinct mode, or style—exaggerating or otherwise distorting certain colors, shapes or proportions—in an effort through more or less obvious external pattern to suggest some characteristic of the author and his theme. The artist who conceives *Rip Van Winkle* as a fairy story and designs his settings for it in the whimsical manner of an illustration for *Jack and the Bean Stalk* employs style. So does the artist who surrounds the action of Strindberg's *The Dream Play* with shapes suggesting the grotesque symbols seen in a nightmare. "Ex-

pressionism" is the best known form of modern stylization. Everyone is familiar with the leaning walls, crooked doorways, and twisted shadows used in the German film production of *The Cabinet of Dr. Caligari* to suggest the distorted mental and emotional reactions of the central character to the world around him. All strongly stylized plays—expressionistic works like August Strindberg's *The Spook Sonata,* Walter Hasenclever's *Beyond,* Eugene O'Neill's *The Hairy Ape;* fantasies like J. M. Barrie's *Peter Pan;* burlesques like Beaumont and Fletcher's *Knight of the Burning Pestle;* psychological studies like Shakespeare's *Hamlet* and *Macbeth*—naturally demand stylized settings.

In a fourth manner the action of a play may be placed theatrically only, in a "formal" [12] setting. This type of scene marks a place for the action, but does not attempt to represent or suggest any given locality. It is always designed very simply, usually in plain architectural forms, such as walls, steps, and platforms. This type of scenery adapts itself to the presentation of Shakespearian and romantic plays, again, as well as many of the older classics.

5. The Function of the Environment: Reinforcing the Action

The second general function of scenery as environment is, through the power of suggestion in surrounding forms, to explain and to give special signifance to the action of a play. This might be termed the reinforcing of action.

Well designed scenery may reinforce the action of a play in a number of different ways. By one method it may explain the

[12] See footnote at bottom of page 29.

action by reflecting the action in visual patterns of thought and behavior. The general appearance of a room, for instance, may be able to tell something about the tastes and habits of the people who live in it. The general tidiness in which the characters keep the room, the color they paint the walls, the kind of chairs they like to sit in, the kind of tools and utensils they use, the incidental, intimate objects they have lying about—all may be made to indicate personality, just as in real life. There are a hundred ways in which surroundings may be made to tell about the thought and behavior of the characters. An example of character explanation through reflection was offered recently in the two rooms Robert Edmond Jones designed for Philip Barry's *Holiday*. One, a sitting room, was a large rectangular room of the Stanford White period, with heavily paneled walls, massive mouldings, tall windows, formal curtains, and stern portraits. It was "a handsome room, and quite a comfortable room, but very, very, rich." The other, a playroom, was an airy, low-ceilinged place of white woodwork, pale blue walls covered with story-book designs, trapezes and toys, thoroughly unconventional and at ease. The two rooms characterized perfectly the two elements of the family of Seton that lived in them.

By another method, scenery may explain action by symbolizing it in such forms as the falling leaves and fading daylight at the close of Cyrano's romance in *Cyrano de Bergerac,* or the rock and mist in Gordon Craig's conception of *Macbeth*.

> I see two things. I see a lofty and steep rock, and I see a moist cloud which envelops the head of this rock. That is to say, a place for fierce and warlike men to inhabit, a place for phantoms to nest in. Ultimately the moisture will destroy the rock; ultimately these spirits will destroy the men.[13]

[13] See Footnote 3 on page 7.

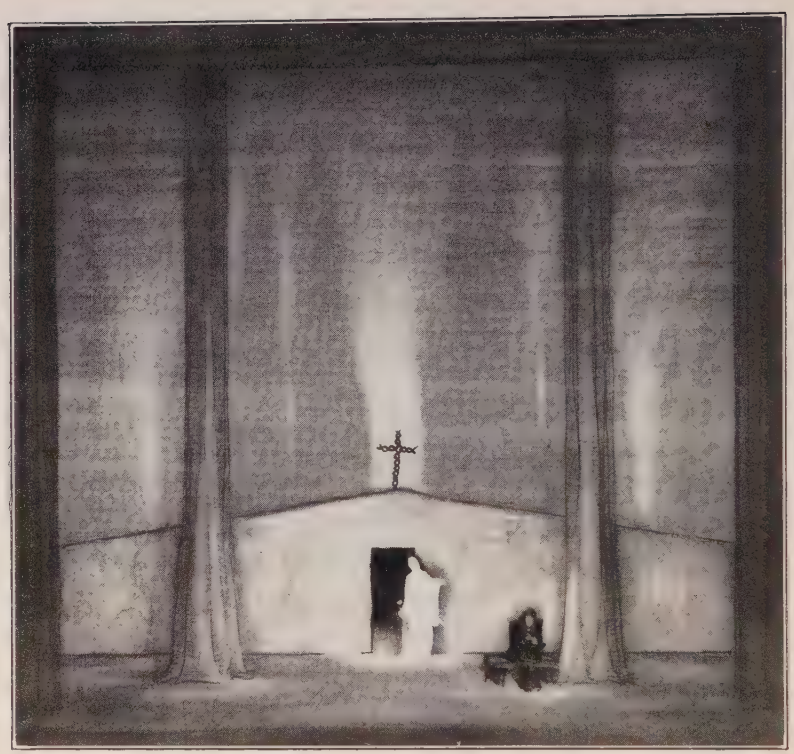
In his interpretation of the same play for Arthur Hopkins a few years ago, Robert Edmond Jones hung three large masks above the stage in several scenes to remind the audience of the ever-present influence of the three witches.

Another example of how a man's pattern of thought and feeling may be explained by symbolic surroundings on the stage (or screen) was furnished in the expressionistic settings for *The Cabinet of Dr. Caligari* mentioned above. The distorted shapes which surrounded the doctor suggested very forcibly his diseased outlook on the world around him.

Again, by the power of suggestion in surrounding forms scenery may describe conditions surrounding the action. By the use of appropriate lighting and certain indicative objects, such as fireplaces and lamps, scenery may describe the time of day and season, and the general weather conditions. By the shape, color, and condition of surrounding forms—walls, furniture, clothes and so on—it may declare the physical circumstances of the characters. Or again, by revealing certain indicative or suggestive forms, scenery may tell or intimate some of the dramatic circumstances in the situation. Consider the gallows with its background of red-coat uniforms in the last act of Shaw's *The Devil's Disciple,* or the tomb filled with its tense shadows in *Romeo and Juliet.* Surrounding forms that describe physical and dramatic conditions in this way help also to reveal personality by supplying forms on which the characters can hang their reactions. The two rooms in *Holiday,* just described, served this purpose. Linda revealed herself constantly by her reactions to the two rooms.

By the power of suggestion in surrounding forms, once more, scenery may create *atmosphere* for the action. That is, it may cause the audience to view the action in a warm, sympathetic

The purpose of the modern artist of the stage in designing a set of scenery for a play is to create a setting which shall put the spectator in the best possible frame of mind to understand and enjoy the play—in other words, to build an *environment* for the dramatic action in the play. An excellent example of such an *environment* is the street scene designed by Robert Edmond Jones for Gounod's *Faust,* produced recently by the American Opera Company.



Another example of scenery designed to be the *environment* of dramatic action. A sketch by Robert Edmond Jones for the setting of one of Pirandello's lesser known one-act plays, *At the Gateway*. In this play under the quiet shadows of the cypresses, cast upon the translucent backdrop behind the wall, there is unfolded a story of ghosts and their memories.

frame of mind. Consider, for instance, a setting for the famous little love scene in the avenue to Portia's house in the last act of *The Merchant of Venice,* suggested by Lorenzo's lines to Jessica:

> How sweet the moonlight sleeps upon this bank!
> Here we will sit and let the sounds of music
> Creep in our ears. Soft stillness and the night. . . .

A setting designed in the spirit of these lines would itself build up a romantic attitude toward the two lovers even before Lorenzo spoke. That is, it would create an "atmosphere." It would make the audience feel like saying to itself: "Moonlight in a garden is a place for love; in such unusually soft and expressive moonlight, in such a beautiful garden, these two young people must be very, very deeply in love."

Atmospheric scenery is what might be called emotional scenery. All the elements of which it is made up, individually and collectively, suggest human feeling. Through the eyes of the spectator they speak to him, in a symbolic language, without words or gestures, something about sadness, or loneliness, or weariness, or joy, or laughter, or some other emotion, and put him into the spirit of the action of the play. In a setting for the scene in the convent park in the last act of *Cyrano de Bergerac,* for instance, the soft fall of leaves, the quiet movement of black-gowned nuns, and the slow fading light through the trees, all help the audience to understand how a poetical old soldier's life is finally drawing to a close. All scenery that suggests in one way or another the thoughts and feelings of the characters that move within it has atmosphere. Gordon Craig's mist-covered rock in *Macbeth,* the contrasting two rooms in *Holiday,* as well as the strange surroundings of *The Cabinet of Dr. Caligari* are

all atmospheric. They "attune the audience to the proper mood for drama."

6. The Functions of the Environment: Dressing the Action

The third (and by no means least) general function of scenery is to make the action of a play pictorially interesting. This function of scenery might be termed the dressing of the action. By the arrangement of the surrounding forms into an attractive composition in line and color, scenery places the action in a constantly appealing atmosphere of "good design," and so adds greatly to the appreciation of the action. This is a very important function of scenery. If scenery does not adorn because it is ugly, it cannot properly be called environmental. Flat, monotonous backgrounds painted in lifeless browns and grays are both tiresome and irritating to look at; they distract attention from the acting and thus weaken the acting, instead of strengthening it. For this reason even the setting for a play which demands "drab surroundings" is rightly designed with life and interest in the matter of line and color. The artist handles these two elements in such a way as merely to *suggest* the faded spirit of the action without actually lowering the warmth of design in the picture. In fact, he may make use of those very details which indicate age and poverty—stained walls, worn woodwork, broken furniture and shadows—to heighten, instead of to lower, the picturesque character of his design.

It is perhaps significant that English speaking designers have, for over two hundred years, employed the term "stage decoration" as a synonym for scenic art. Continental artists have made use of a similar word, *decor*.

The pictorial composition of scenery will be discussed at greater length in Section 10 of this chapter.

7. The Four Elements of the Stage Setting

The designing of a "stage setting" (a complete set of scenery in the comprehensive sense—see Sect. 3) involves the planning of four related and co-ordinated elements: (1) scenery (in the limited technical sense—see Sect. 3)—background forms that represent walls, archways, the sky, trees, fences, and the like; (2) properties—furniture and incidental objects; (3) costumes—clothes worn by the actors; and (4) lighting—specialized illumination.

(1) Scenery (proper) is the background element of the environment. It places the action, sometimes in only a very general sort of way, and sketches in certain of the decorative and dramatic values of the visual scene, behind the other elements.

(2) Properties make the visual scene intimate by relating it directly to human action. As the objects which the characters in the play handle, upon which they sit or lie, and about which they talk constantly, properties have a strongly dramatic value in the setting. They frequently place action in quite a definite way. Also, by entering into the mass and line composition of the scene they exert a decorative influence on the action. A bookcase, cupboard, or mirror in an interior setting, for instance, may be made as important a feature in a wall arrangement as a door. A long, low table or couch may be employed to give the right line of contrast to a tall, narrow panel—and so on. Properties enter very obviously into the color composition of the scene, also. With the tendency to keep the larger areas of the background fairly neutral and to accent only the smaller objects, placed in it

or in front of it, a set of scenery generally looks very bare until it has been dressed up with furniture, window hangings, table covers, books, flowers, and the like.

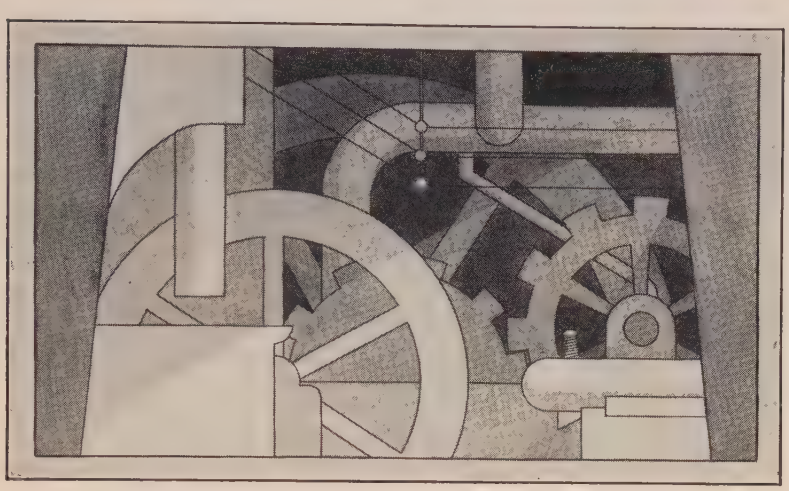
(3) Costumes, also, play a vital part in the composition of a stage design. Color here, if properly handled, has the same value as color in properties—often more, because it has the added advantage of being constantly in movement. Milton Smith terms costumes, very appropriately, "scenery worn by actors." [14] The most pronounced accents in the whole scene are often placed in these bits of moving scenery.

(4) Light is one of the artist's most valuable instruments in design—placed first by some designers. By the manipulation, through the services of selective lighting units (Part Two, Ch. IV, Sect. 7–9) of masses of color, highlights and shadows, light helps powerfully to compose the color, mass, and line elements of the scene and to intensify the dramatic values. (The principles of designing by light are outlined in Part Two, Ch. VI.)

In the ideal, and the only really logical, plan of scenic design a single artist conceives the entire setting. He designs the scenery, selects (or causes to be made) the properties, plans the costumes, and works out the lighting. Because of certain difficulties in modern production, however, especially in the preparation of elaborate costume plays, it is not always possible for one man to do all of the detailed, creative planning in each of the four departments of design. Nevertheless, if the final environmental expression is to be unified, it is imperative that the first conception and the general supervision of the entire work be that of one artist.

The study of scenic art in Part One of this book is centered

[14] Milton Smith: *The Book of Play Production*, D. Appleton, 1926.



A Design for Andreyev's King Hunger. The Factory

on the construction, painting and assembling of scenery (in the limited sense of the term). Because the planning of scenery cannot very easily be disengaged from a consideration of properties, costumes, and lighting (especially the first), however, these three complementary elements must always be felt to be involved at least indirectly in any consideration of scenic design mentioned in the following chapters.

8. The Seven Requirements of the Stage Setting

The stage setting conceived as the visual environment of the action of a play should be so designed, as has already been suggested, that it will place, reinforce and dress the action. The designer of the setting should, therefore, plan it to be: (1) expressive of a theatric locality, and of the thought and spirit of the action of the play, (2) pleasing to look at, (3) capable of being appreciated from the position of the audience, (4) simple in

design, (5) capable of being used well by the actors, (6) capable of being efficiently constructed, assembled, and handled, and (7) related in design to the other contributive elements in the proposed presentation of the play. In brief, the designer should aim to make the setting:

(1) expressive
(2) attractive
(3) projectile
(4) simple
(5) utilitarian
(6) practicable
(7) organic

How the artist may design his setting to fulfill these seven requirements is suggested in the following outline. The reader is referred to Chapter II for a description of some typical forms of scenic arrangements; to Sections 4–5 and 9 of the present chapter for an explanation of how scenery is made expressive; to Section 16 of the present chapter for a suggestion on the choice of style; and to Part Two, Chapters VI and VIII for an exposition of the methods of designing by light.

9. Making the Stage Setting Expressive

First, a stage setting should be *expressive*. By the power of suggestion in the visual forms surrounding the action, as has already been said, it should help to make clear the idea and spirit of the play; that is (1) it should place the action realistically, suggestively, stylistically, or formally, and (2) it should reinforce the action by explaining it, describing the conditions surrounding it and creating atmosphere for it. How the artist may design an expressive scene is suggested in Sections 4 and 5 of the present

chapter. Several typical arrangements of expressive settings are illustrated in Chapter II, Sections 4–7.

10. Making the Stage Setting Attractive

Second, a stage setting designed to be the environment of the action of a play (Sect. 3) should be *attractive*. By the use of pleasing shapes and colors in surrounding forms it should set off the action, and make it appear at all times "good to look at" (Sect. 6). The artist must select for the design of his scene objects which have interesting and graceful qualities and arrange these according to the "rules" of good composition.

A well composed scene has, first, unity. All of its parts (the mass, line, and color forms of the larger units of scenery, the properties, the costumes, and the lighting) are made to appear to belong together; they all contribute to the expression of one idea. This idea, of course, is that of environment particularly appropriate to the action for which the scenic forms are planned. The environmental idea to which all the parts of a design for the first act of Philip Barry's *Holiday* (Sect. 5) should be contributive, for instance, would be that of a "handsome room, and quite a comfortable room, but very, very rich." The idea in a design for the first act of *You and I* by the same author, on the other hand, would be "A huge, uneven, motherly sort of room that pats your hand as you come into it, and tells you to sit down and be comfortable with the rest of us," and so on. Securing unity in a design involves then: (1) the selection of only those elements which may be related to each other and made contributive to the environmental idea (with the consequent elimination of all unrelated and non-contributive material); (2) the arrangement of the elements chosen into a plan that gives

special emphasis to that feature, or group of features (the "motifs") which most clearly express the environmental idea; and (3) the maintenance of a single style throughout the design. A unified scene may be said to be one that is "well focused."

Also, a well composed scene has variety. That is, it avoids monotonous repetition. Identical shapes and colors are not made to appear everywhere. Forms with vertical lines are varied with forms with horizontal lines, round objects are varied with square objects, intense colors are varied with neutral colors, light colors with dark colors (Ch. VI, Sects. 6–7), and so on—contrast, a friendly rivalry, is introduced between the elements of the picture to make the design alive and interesting. If, in designing a scene to represent a sitting room, for instance, the doors and windows are made square, certain other details may be rounded; if one color, somewhat neutralized, is selected for the walls, another quite dissimilar one, somewhat brighter than the first, may be picked for the window hangings, table covers, certain pieces of pottery, lampshades, and other objects standing in front of the walls; and so on. Variety cannot be demanded at the expense of unity. If, however, the primary motif is allowed to dominate at all times, that is, the central idea of the scene is made constantly clear, there is little danger of unity being lost through contrast and variety in the contributive elements of the design. In fact, by their very difference from the main motif they have a tendency to call attention to it and thus sharpen up the sense of unity.

Again, a well composed scene has balance. The prominant architectural features (such as the doors and windows), the larger pieces of furniture, and all the other objects of special pictorial or dramatic interest, are so distributed on the two sides of

the stage that they "weigh" against each other more or less equally. Color, also, must be put into equilibrium; likewise all the rest of the conflicting elements set in motion by the principles of variety just mentioned.

Finally, the well composed scene has harmony. In it all of the different elements co-operate in a friendly way to make an attractive whole. This is obviously the outcome of successfully giving the design unity, variety and balance.

11. Making the Stage Setting Projectile

Third, the stage setting should be *projectile*. That is, it should be designed in such a way that it will make a good impression and make clear its purpose at a distance. The majority of the members of the audience must view the "stage picture" from seats placed twenty to fifty or more feet away. Because the picture must be appreciated remotely it is clear that its design must be quite simple and exaggerated. Line and color forms must be made big. Fussy details which cannot be seen clearly from a position in the audience, and hence tend to confuse the more important elements of the scene, should be omitted, and the emphasis should be laid on the larger effects. A wall paper pattern which in a real home would be composed of a dozen small figures in a dozen neutral colors, for instance, might be redesigned for use on the stage with three larger figures and three brighter colors. A body of foliage might be designed in large masses of green, rather than in individual leaf forms, and so on. If a set of scenery is to project itself well across the footlights, then, it must possess the quality of "bigness" in all its parts.

12. Making the Stage Setting Simple

Fourth, the stage setting should be *simple*. Knowing that scenery cannot be fully expressive, attractive, or projectile if its plan is not clear, the artist should endeavor to keep the design of scenery uncomplex. He should select only those elements which will contribute to the development of the main idea, eliminate everything that is not related and essential, and then compose the elements that he has retained into an orderly, unified, significant stage setting.

A point should be noted here, however: *a simple design need not be a bare one*. This fact very often is not appreciated. Simplicity is commonly associated with meagerness, quite wrongly. It makes little difference whether a stage setting is composed in five lines and one color or fifty lines and ten colors, it is simple if its plan is uncomplex—that is, if the spectator can grasp without effort the thought and emotion it is designed to express.

The artist attempts to make his scenery simple, not only dramatically, but also technically. He plans it so that it can be constructed, painted, and assembled with the minimum waste of time and materials (Ch. IV, Sect. 2).

13. Making the Stage Setting Utilitarian

Fifth, the stage setting should be *utilitarian*. That is, it should be planned so that it can be used efficiently and effectively by the actors. The artist must provide for, in the places where they are most needed, the entrances, exits, platforms, steps, chairs, tables, and other means for walking, standing, sitting, and lying down demanded by the action. The artist must see that his scenery is not only effective for action, but also safe and

strong enough for action. That is, he should make certain that a platform that must bear the weight of a number of people is properly reenforced, that a wall, or a door against which an actor is to fall at some moment in the play is properly braced, and so on. All these points he must work out carefully with the director.

14. Making the Stage Setting Practicable

Sixth, a set of scenery should be *practicable*. That is, it must be capable of being efficiently constructed, assembled and handled; in other words, first, it must fulfill the general technical requirements of scenery making, and second, it must meet the specific technical demands of a particular stage (or class of stages, if the scenery is planned for touring).

First, to make the set of scenery fulfill the general technical requirements of scenery (Ch. IV, Sect. 2) the artist must design it to be capable of:

(a) being easily and rapidly constructed,
(b) being economically constructed,
(c) being quickly and silently shifted,
(d) withstanding strain and wear,
(e) being well assembled,
(f) being packed or stored away.

This means that the artist must plan his scenery so that it can be constructed, as far as possible, in accordance with the standard methods outlined in Chapter IV.

Second, to make the set of scenery meet the specific technical demands of a particular stage (or group of stages) the artist must consider (a) space (Ch. II, Sects. 2 and 10) and (b) shifting facilities (Ch. VII, Sects. 5–12).

(a) The set of scenery must be capable of being placed on the particular stage in such a way that:

the sight lines are good (Ch. II, Sect. 10),

the wings, the flies, and all other parts of the stage or scenery that are not supposed to be seen, are properly masked (Ch. II, Sect. 10),

there is space for packing the scenery that is not in use in a given act, and

there is space for the manipulation of properties, lighting apparatus and actors.

Before starting to design his setting, then, the artist should make himself thoroughly familiar with the size and shape of the stage on which the scenery is to be set up, including such points as:

the width of the stage,

the depth of the stage (from the curtain line),

the width and height of the practicable proscenium opening (that is, with the tormentors and teaser in positions for good sight lines),

the height of the gridiron (if units must be flied out of sight), and

the height of the fly floor (if tall units must be placed under it).

(b) The set of scenery must be capable of being shifted, on the particular stage, efficiently and safely. Before starting to design the scenery, therefore, the artist should make himself familiar with the character of the stage equipment, including such points as:

the number of sets of lines,

the strength of the lines,

the strength of the loft and head blocks,

the strength of the grid supports,
the arrangements of any counterweighting devices,
the strength of the stage floor,
the arrangement of any special shifting devices, and
the arrangement of storage spaces.

Chapter II outlines the usual plans for placing scenery on the stage and Chapter VII the standard methods of changing scenery.

15. Making the Stage Setting Organic

Seventh and finally, the stage setting should be *organic*. That is, the design of the scenery as a part should, in character and purpose, be carefully subordinated to the design of the play presentation as a whole (Sects. 1–3). If there must be unity in the lesser design (Sect. 10), there certainly must be unity in the greater design (Sect. 1). The scenic artist, must therefore work at all times in strict co-operation with the director and other artists of the theatre in the mutual effort to produce that one impression of the whole which will best express to the audience the thought and spirit of the play and make possible its full enjoyment.

The fact that *environment,* vital as it is, can never rightfully occupy the place of first attention on the stage is a point which ambitious young designers frequently forget. So keenly do they become interested in the purely picturesque character of a stage setting that they lose sight of the living, human element (expressed through *action*) which must be placed within scenery to give it its real significance. An unusually brilliant background wall, a startlingly vivid expanse of sky, a peculiar arrangement of proportions and colors, or an odd handling of light, may

give scenery a striking appearance when viewed alone, but make it fail to keep its place when viewed with actors. In such a situation the attention of the audience is drawn to the "surrounding circumstances," away from the thing surrounded, and the *environment* loses its essential character. The implication here is not that good scenery should be undistinguished—forcible effects are often appropriate, and even necessary—but that in an organic design of a play presentation it should recognize its position always as the servant, rather than the master, of the *action*. This point cannot be stressed too strongly.

16. Style in Scenic Design

Demanding a far greater freedom in expression than that permitted his convention-bound predecessor of twenty years ago, the scenic designer of today, searching for what he feels to be the best form in which to build his conception of scenery for a play, may make use of one of a variety of modern styles, or he may create his own. If he decides to use one of the styles in vogue he has a wide choice. Among the more popular styles from which he may select are: Realism, the mode of using forms which give a definite, life-like (though not necessarily a complete) portrayal of an actual or imaginary locality appropriate to the action (Sect. 4); Suggestion, the mode of using forms which intimate a locality without describing it (see the same section); Stylization, the mode of using forms which employ a somewhat exaggerated, or distorted, or otherwise "unnatural" external pattern in order to suggest the characteristics of an author and his theme (see the same section); Expressionism, the special phase of Stylization which lays emphasis on the abstract "expression" of ideas; Formalism, the mode of using

forms which mark a place for action but do not attempt to represent or suggest any given locality (see the same section); and Constructivism, a kind of Expressionistic Formalism, peculiarly Russian. There are other styles, of course—each grown out of a certain theory of which there are apostles and disciples as rabid in their beliefs as are some religious fanatics.[15]

The wise artist, however, calls himself a follower of no one theory. Each play, he maintains, has a distinctly different individuality. In designing the environment of its action, therefore, the artist must leave himself free to choose between different forms.

When one considers the range of style of one such playwright as O'Neill, for instance, one realizes how important it is for the designer, the interpreter of many totally dissimilar playwrights, to keep his own modes of expression flexible. If he allows his own individuality to obtrude in his work, he limits himself as an artist and is dishonest to his calling.

Because it would be wholly impossible in this brief book to take up the study of scenic forms through each of the many current styles, one kind only will be analyzed to any length in the following chapters, the representative, or "realistic." This type of scenery will be considered, not for a dramatic reason, but for a technical one; because the principles underlying the construction, painting, assembling, and designing of forms in this style may be more widely applied than those of any other one style. The simple directions put down here may be adapted

[15] For a more detailed description of style the reader is referred to Sheldon Cheney's *Stage Decoration* and to other books listed in the Bibliography. In any study of the modes of design is must be borne in mind that styles are very elastic; Expressionism, for instance, will mean one thing to one man and something entirely different to another. Some readers may prefer to the general terms Realism and Formalism used above, Tasteful Realism and Modified Formalism. Extreme styles that are not environmental in character cannot rightfully, of course, be included in the present discussion.

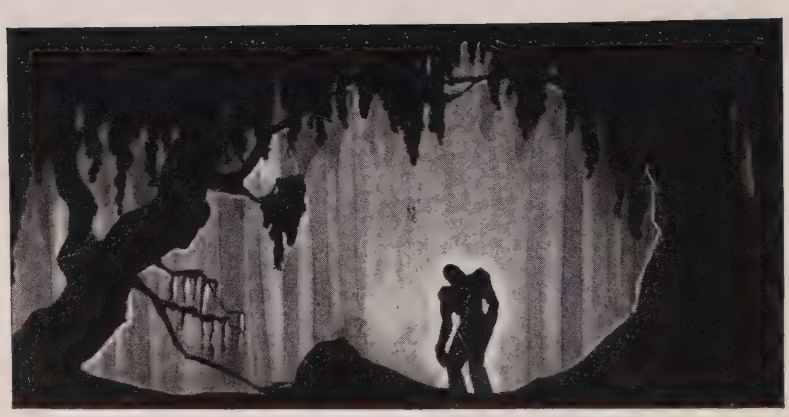
for use in almost any form of scenic expression, from Naturalism to Constructivism.

17. A Summary

In this chapter, which attempts to analyze the objective of scenery, it has been shown that play presentation must be considered as a unified design made up of a number of members—acting, dancing, music, scenery, costumes, lighting, and so on—all co-operating under the guidance of a director to produce a single emotional effect upon an audience. At the heart of the design is theatric action. It is the purpose of scenery, one of the contributive arts, to function as the visual environment of this action by placing the action, reinforcing the action, and dressing the action. The artist who designs a set of scenery causes it to fulfill completely this environmental duty when he makes it expressive, attractive, projectile, simple, utilitarian, practicable, and organic, in a style appropriate to the play.

Scenery is usually designed in one, or in a combination, of four principal "styles" illustrated on this page and the following. The more or less complete representation of an actual subway car, designed and executed by Messrs. Cirker and Robbins for Edward Blatt's production of *Subway Express,* is an example of *Realism* (in the extreme, naturalistic sense).

The village railway station, intimated simply by three small wall sections, a map and a few chairs, designed by Lee Simonson for the Theatre Guild production of *The Failures,* is an example of *Suggestion.*



Two water color sketches by Ronald A. Jones for *In Abraham's Bosom* by Paul Green.

CHAPTER II

SOME COMMON FORMS IN SCENERY

1. Introduction

Before the scenic artist can start to make scenery [1] it is necessary that he learn thoroughly the form of scenery. This chapter is devoted to a brief study of the standard parts out of which a set of scenery is produced. After glancing at the physical features of a typical stage, the reader will be asked to examine, in turn, the unit forms of scenery, some representative arrangements of these units into scenes, the question of sight lines and masking, and the problem of sky-effects.

In considering the opening section on the physical stage the reader should realize that it is frankly a sketch, included here to make the following sections on scenery more intelligible. If he wishes to secure a more detailed knowledge of model forms and equipment on the stage he should go to Irving Pichel's *Modern Theatres,* and to other books listed in the bibliography.

2. The Topography of a Typical Stage

The transverse wall dividing the auditorium from the stage is the *proscenium.* (Figs. 1 and 2.) The opening in this wall, whether rounded or square at the top, through which one sees the stage, is called the *proscenium arch.* Behind the proscenium

[1] *Scenery* in this chapter and in the following chapters of Part I is used in its more limited technical sense (see Ch. I, Sect. 3).

arch, the spaces off-stage to each side are the *wings*—that to the right, facing the audience, the *right wing,* that to the left, the *left wing*. Here are located the exit to dressing rooms, the loading door, through which scenery is brought in and taken out), often a door to a special property room, the switchboard, the counterweight system—if the equipment includes this (Ch. VII,

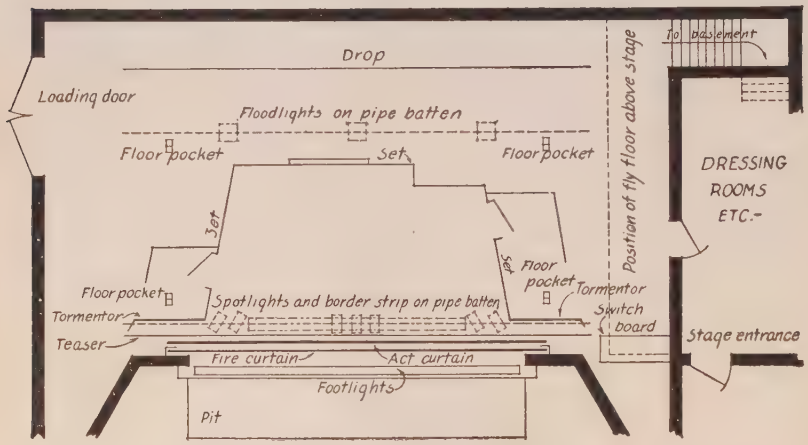


Fig. I. The Plan of a Typical Stage

Showing the usual positions of the fire and act curtains, the teaser, tormentors, footlight trough, overhead lighting units, loading door, fly floor, and other features, beside a set of scenery in place. The stage is 52 ft. wide and 28 ft. deep with a proscenium opening of 28 ft. Scale $\frac{1}{16}'' = 1'-0''$. (See Fig. 2)

Sect. 8)—stacks of scenery, properties, lighting apparatus, safety devices, a clock, and the stage manager's prompt desk. The floor of the stage is of soft-wood boarding, usually tongue-and-groove yellow pine, laid parallel to the proscenium from the front to the back wall. It is frequently pierced by *traps* which open into the basement to permit the use of sunken stairways, etc., and is covered in performance by a large piece of heavy waterproof

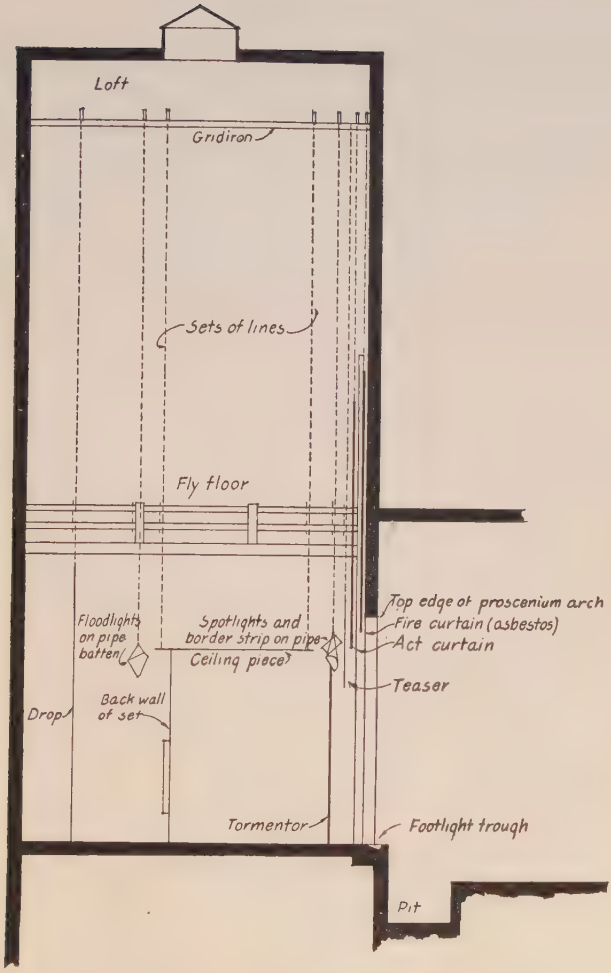


FIG. 2. A VERTICAL SECTION OF A TYPICAL STAGE

Showing the positions of the fire and act curtains, teaser, one tormentor, footlight trough, overhead lighting units, fly floor, gridiron, and other features, beside a set of scenery in place. The stage is 28 ft. deep (from the curtain line), and the gridiron is 60 ft. above the floor. Scale $\frac{1}{16}'' = 1'-0''$. (See Fig. 1.)

duck called a *ground cloth*. The *footlight trough* is located along the edge of the stage floor nearest the audience.

At the top of the space above the proscenium, known as the *flies,* is the *gridiron* or *grid,* a steel or wood framework of open beams placed five to ten feet below the roof, forty to a hundred, or more, feet above the stage, and extended over the entire working area. From this frame is suspended all the hanging scenery such as drops, borders, tree trunks, etc., as well as certain lighting units. *Sets of lines* are attached to each hanging piece, passed over pulley blocks in the grid, brought down, and tied off on a double row of belaying pins, called the *pin rail,* on the *fly floor*. The fly floor is a shelf, or narrow gallery, extending along the wall of one of the wings some distance above the main floor. A more detailed description of the gridiron and the fly floor will be found in Chapter VII, Section 5. In many of the newer theatres the fly floor has been omitted and all hanging scenery is handled with a *counterweight system* operated from the floor. This method also is described in Chapter VII, Section 8. Under the general subject of flies mention might also be made of the occasional *bridges* found in some theatres. These are light, narrow steel frames which, extending across the stage, may be fixed, moved on tracks, or suspended from the grid some distance above the floor, and are now used principally for mounting overhead lighting units.

We have just considered the stage and some of the permanent, built-in equipment. Now let us look at the principal adjustable "masking pieces." Returning to the proscenium opening—the two perpendicular and movable screens that mask from the audience the spaces on each side between the down-stage edges of a set and the proscenium arch are the *tormentors*. These, together with the horizontal screen or mask known as the *teaser*—

usually a simple, dark colored border or piece of drapery suspended above, between the arch and the tormentors—form an adjustable inner frame for the stage picture. The *act curtain,* or

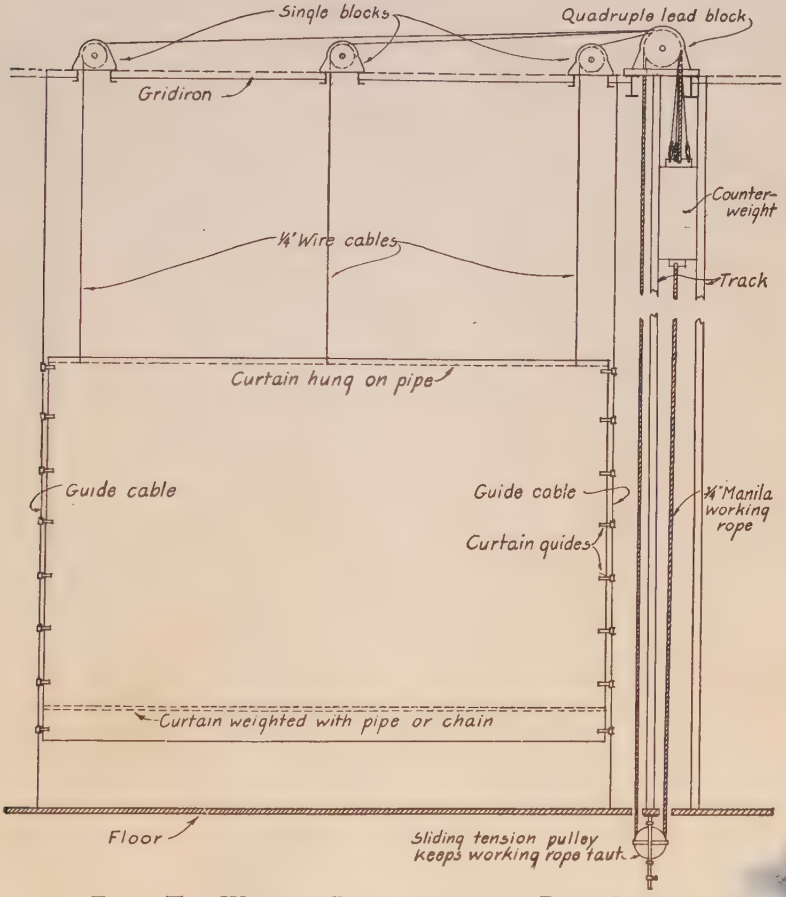


FIG 3. THE WORKING PRINCIPLES OF THE DROP CURTAIN

The size of the rigging parts in relationship to the curtain in this picture has been exaggerated somewhat in order to make clear the way in which they work.

house curtain, closes the proscenium opening between the arch and this inner frame. On most of the larger stages the curtain is of the *drop type* (Fig. 3), suspended from the gridiron and rigged, balanced, and operated with an endless rope on the same general principle as a unit of the counterweight system (Ch.

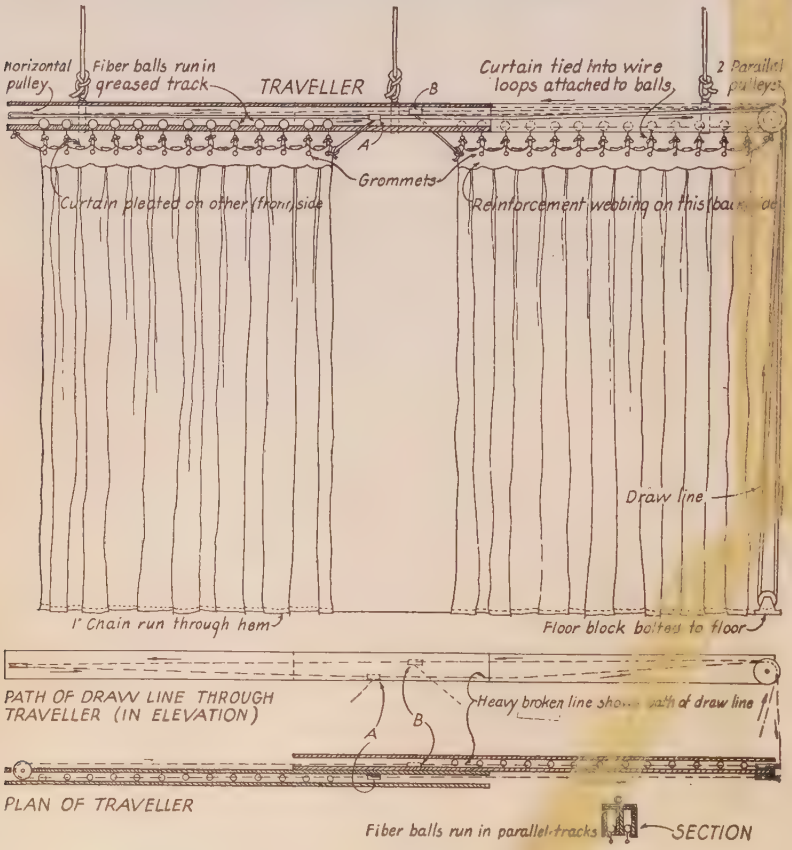


Fig 4. The Draw Curtain on a T[illegible]eller

The path of the draw line through the traveller is indicated in the diagram just below the curtain. When the line is [illegible]n in the direction indicated by the arrows the curtain is closed.

VII, Sect. 8 and Fig. 54). Other common curtains, used more frequently on small stages, are the *draw* type (Fig. 4), in which two sections, parting in the middle and tied to a number of wooden or fibre balls made to slide in a slotted track called a *traveller,* are pulled on and off without raising or lowering the curtain as a whole; and the *tableau* or *tab* type (Fig. 6), in which the two sections are gathered up at the sides.

Fire regulations in most cities require that every theatre, commercial or otherwise, be equipped also with a steel or asbestos *fire curtain.* It hangs in front of the house curtain and, when dropped, completely seals the proscenium opening.

The reader should remember that in all references to positions on the stage floor, *down-stage* means toward the audience and *up-stage* means away from the audience. *On-stage* is toward the center of the stage, *off-stage* is toward the wings or the rear wall. *Right* and *left* are determined from the point of view, not of the audience, but of the actor facing the audience.

3. Unit Scenery

After dramatic and decorative requirements have first been considered, scenery must be designed for ease and rapidity of assembling and shifting on the stage. The interest of an audience can be held and intensified as a performance progresses only if the time required for changing scenery is reduced to a minimum. Because most modern stages are comparatively small and changes still have to be made by hand, the unit system in scenic construction is almost universally employed. Each set, whether simple or elaborate, is built up of a number of wood and canvas screens, platforms, and other light framed pieces, which are so designed that they may be assembled or taken apart

quickly and easily. Every unit of standard-built scenery has a maximum width of only five feet nine inches when packed. This dimension (plus three inches allowed for clearance) is the exact size of the freight car door through which all units must be made to pass when the play goes on tour. The maximum width

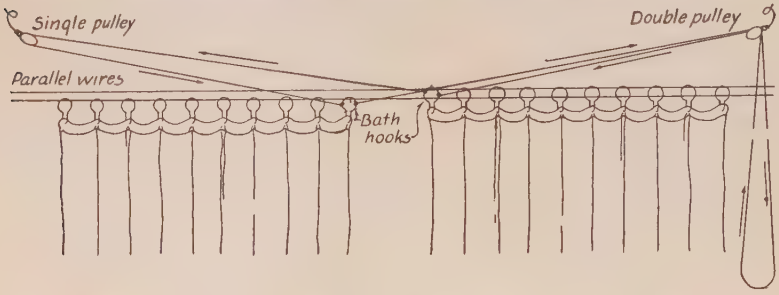


FIG. 5. A SIMPLE HOME-MADE DRAW CURTAIN ON WIRES
The two wires are fastened to the side walls of the stage at the same level and drawn taut by means of turnbuckles.

of five feet nine inches offers a number of other advantages in construction and handling—at home as well as "on the road." For one thing, frames of this size are easy to cover (Ch. IV, Sect. 9), and for another, they are easy to assemble and shift, and to store away (Ch. VII, Sect. 13).

The most common forms of unit scenery may be grouped under five general heads.

(A) STANDING UNITS:

flat (plain)—A tall screen made of wood and canvas, with a standard width of five feet nine inches, but no standard height, used as a section of a wall. (Fig. 23)

flat for a door—a flat with an opening for a door frame. (Fig. 24)

flat for a window—a flat with an opening for a window frame. (Fig. 24)

flat for a fireplace—a flat with an opening for a fireplace frame. (Fig. 24)

jog—a narrow flat. (Ch. V, Sect. 4)

two-fold—two flats hinged together to fold inward, face to face. (Ch. V, Sect. 4)

three-fold—three flats hinged in the same way. (Ch. V, Sect. 4)

return—two flats hinged together to fold outward, back to back. (Ch. V, Sect. 4)

door frame unit—a solid wood door frame made to fit in a flat designed for it. (Fig. 25)

window frame unit—a solid wood window frame made for a similar purpose. (Fig. 28)

fireplace unit—a fireplace frame, not always solid, made for a similar purpose. (Fig. 30)

archway—a flat with an arched opening, usually constructed with a detachable thickness. (Fig. 31)

(B) Hanging Units:

ceiling—a large, horizontal, canvas-covered frame, suspended by a set of lines from the grid, used to close the top of an interior scene. (Fig. 32)

drop—a large sheet of canvas, partly or fully framed, suspended vertically on a set of lines from the grid—commonly used to represent the sky. (Fig. 34)

border—an abbreviated drop, occasionally used to represent foliage or to mask the flies. (Fig. 34)

tab—a sheet of canvas or other material, framed or unframed, smaller than a drop but suspended like it, used for a variety of purposes. (Fig. 34)

cyclorama—a large curtain of canvas, or other material, hung from a horizontal U-shaped wood or metal frame suspended by a set of lines from the grid—commonly used to represent the sky in exterior scenes, as well as for a number of other purposes. (Fig. 36)

(C) Built Units:

platform—a collapsible and portable frame platform constructed in unit sections. (Fig. 38)

steps—a light, portable run of steps constructed in unit sections. (Fig. 39)

column—a light frame or canvas column. (Fig. 40)

tree—a light frame or canvas tree trunk. (Fig. 40)

rock—a light, irregular frame-and-canvas imitation of a rock, made in unit sections. (Fig. 41)

built-up-ground—the same kind of an imitation of a bank of earth

(D) Set Units:

ground row—a flat profile of a bank of earth, or a distant mountain, painted on thin three-ply veneer board, cut out, framed behind, and made to stand up independently on the floor. (Fig. 42)

fence or wall—a frame imitation of a fence or wall, designed to stand up independent of other units on the floor. (Fig. 43)

set house, etc.—various frame units, designed like the fence to stand up independently. (Fig. 44)

(E) Draperies:

Under this head may be listed a variety of curtain units, largely unframed.

These units might be called the "standard parts" of scenery. Many non-standard forms must be designed occasionally to meet special demands; but the units listed are used exclusively in the majority of plays.

The three principal methods—employing the lash-line, the loose-pin hinge, and the bolt—by which the units may be fastened together, are described in Chapter IV, Section 10.

4. The Arrangement of Scenery

In the last section are listed twenty-seven common forms of unit scenery. The number of designs into which these standard parts may be assembled is almost limitless. Flats, door, window,

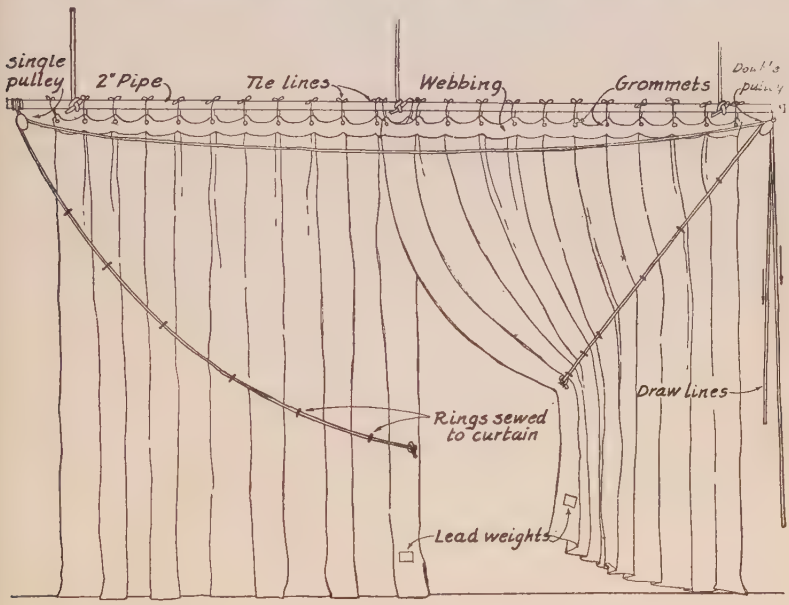


Fig. 6. The Tab Curtain

This curtain is not generally so satisfactory for closing the front of the stage as the drop or draw curtain.

and fireplace units, ceilings, drops, and frequently steps, columns and other units may be combined to represent descriptive indoor scenes in a wide variety of shapes and styles; while drops or cycloramas, trees, fences, ground rows, and frequently flats, columns, and other units may be put together to suggest realistic out-of-door scenes in an equal variety of forms. These or other

units, again, may be united to make formal, poetic, or expressionistic backgrounds.

There is no standard arrangement of standard parts. Certain general arrangements are, however, fairly characteristic of some of the more common classes of scenes. Six examples typical of their kind—three frame indoor settings, called *interiors,* two frame outdoor settings, called *exteriors,* and one drapery cyclorama setting—are described in the following three sections. When the reader studies the six settings he must bear in mind that they represent scenic environment stated in very simple terms. An intelligent artist who wishes to make use of the principles suggested here may adapt and elaborate as he pleases in his own designs.

5. Three Typical Interior Settings

The simplest form of interior that makes use of a full set of descriptive scenery is the *box-set.* This represents any ordinary chamber—bedroom, sitting room, kitchen, or hall—with three walls and a ceiling. Figure 7 shows the front view and plan of a typical box set. The walls are made up of seven flats placed edge to edge—two on each side and three at the back—which are laced together by means of lash lines thrown over lash cleats (Ch. IV, Sect. 10) and braced from the floor, where necessary, by stage braces (Ch. VII, Sect. 3). The flats up-right, and down-left and center-back (Sect. 2 of this Chapter) are pierced with holes to accommodate solid door and window frames, which are clamped in position in setting the scene and may be removed from the flats in "striking" (taking down) the scenery. A fireplace frame is placed in a similar way in the flat down right. A ceiling piece, hung on two or three sets of

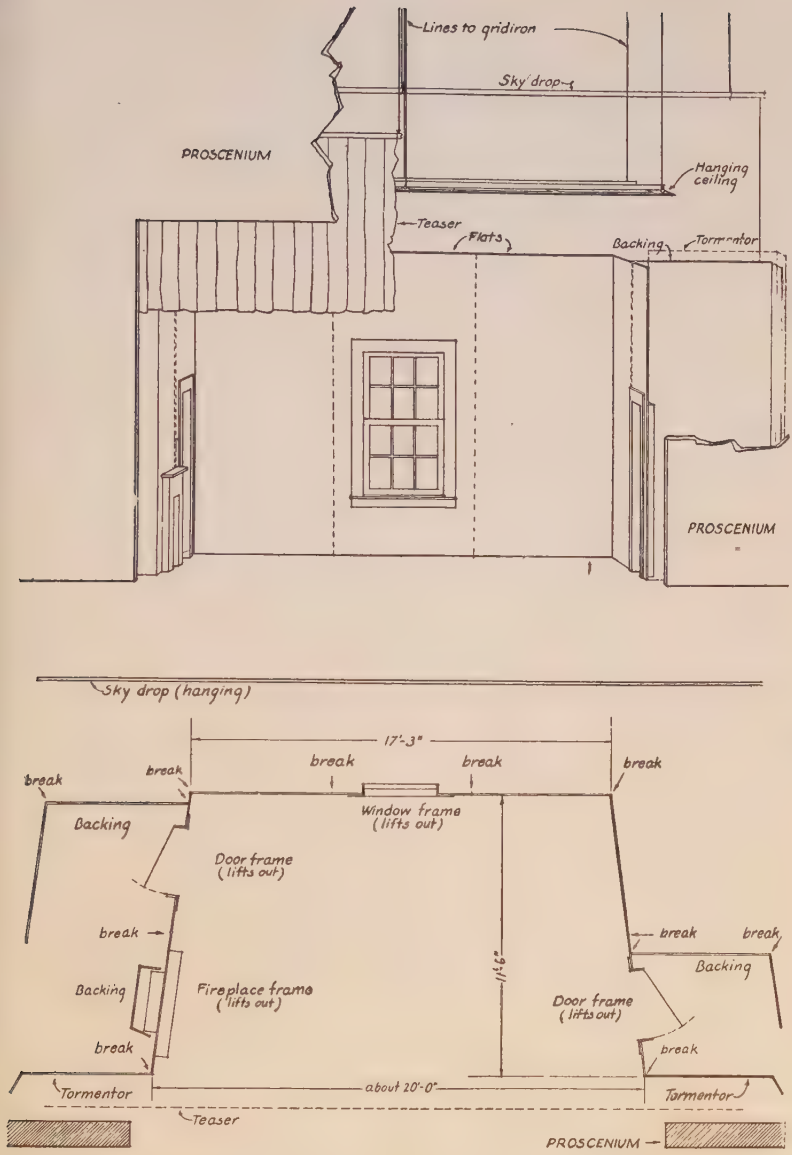


FIG. 7. A SMALL BOX SET IN FRONT VIEW AND PLAN

Showing a typical arrangement of walls, door, window and fireplace frames, ceiling, sky drop, backings and front masking pieces.

lines, closes in the room above. A sky drop acts as a background for the view through the window and two-fold backings, or spare flats lashed together, shield the views through the doors. The front edge of the set all the way around is framed in by means of the adjustable teaser and tormentors.

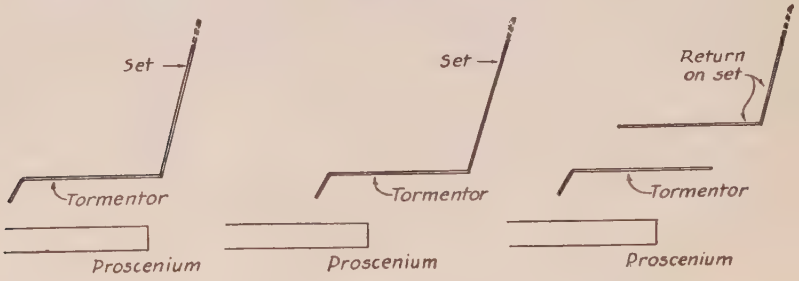


Fig. 8. The Tormentor and the Return

These diagrams show how the proscenium opening may be opened out or narrowed on each side by shifting the position of the tormentor, or by making use of an additional return. If side lighting units on standards are required on a set they are frequently placed between the tormentor and the return. In this case a 12″ or 18″ thickness is usually placed on the on-stage edge of the tormentor to shield the light from the audience, and the return is pulled back to allow the lighting unit to be angled freely onto the set. A teaser (see Fig. 7) serves as an adjustable masking piece above.

Because the straight box set is so plain in shape it is seldom used now without some adapting. A turn is given to the walls, an alcove is added, or another room is made to open off the set in an unusual way, in order to give the set at least some little new interest. In the floor plan in Figure 9, for instance, the right and rear wall have been set on a bias in order to give the impression that one is looking into the corner rather than into the flat side of the room. Also, a jog has been introduced into the back wall in order to keep it from being perfectly straight. Except

for these features the room is quite conventional. A photograph of the setting diagramed here may be seen opposite page 130.

A slightly different arrangement of interior scenery is shown in the floor plan of the setting Cleon Throckmorton designed for the palace scene in the first act of Eugene O'Neill's *Emperor Jones,* as produced at the Provincetown Playhouse and later at

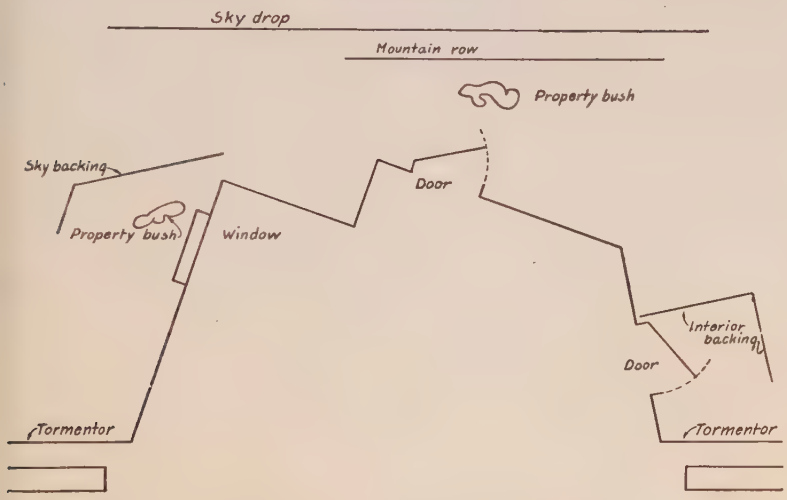


FIG. 9. THE FLOOR PLAN OF AN INTERIOR SETTING

This is the floor plan of the setting for *Day's End,* by Edith Daseking, opposite page 130.

the Plymouth Theatre in New York (Fig. 12). This set consists of five flats and a jog, three of the flats being made into two archways, one large and one small. The view through the greater archway at the back includes a large column, and a built-up frame representing distant mountains. The effect of sky (which could be given almost as convincingly by means of a sky drop) is here produced by a light blue cyclorama (Sect. 11). A ceiling closes the set in above, and a two-fold backs the

view through the smaller archway. This set was enlarged somewhat when it was moved to Broadway.

There is, of course, no standard size or shape for interiors of the general type represented by the three settings described here. They may consist of any number of flats and be of any

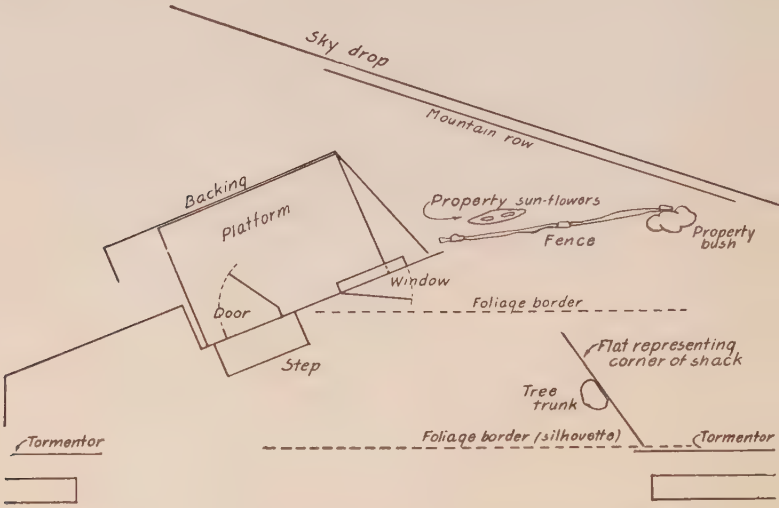


FIG. 10. THE FLOOR PLAN OF AN EXTERIOR SETTING

This is the floor plan of the setting for *A Shotgun Splicin'*, by Mrs. Oscar J. Coffin, opposite page 130.

reasonable height, depending only on stage conditions and the size of the proscenium opening. Four other typical arrangements of indoor scenery are diagramed in Figure 11.

6. TWO TYPICAL EXTERIOR SETTINGS

A simple arrangement of scenery to represent an out of door setting is shown in the country post office scene reproduced in

the photograph opposite page 130 and the floor plan in Figure 10. The set consists of seven flats and four jogs arranged in the manner shown in the drawing. The store-front is made up of three flats and three jogs lashed together and braced (see preceding section); the backing is made up of three other flats and a jog; and the face of the shed at the left uses the other flat. A solid door and a solid window are placed in the flats cut for them. There are also a raised doorstep in front of the store, with a low platform inside to continue back the raised level; a set fence and a set bed of sun-flowers, at the side; a frame tree trunk down left; and a sky-drop. A painted profile mountain row is placed at the foot of the sky drop both to mask the lower batten of the drop and to add pictorial interest to the background. Because no ceiling piece can, of course, be used in this exterior, the tops of the flats at the right are continued up far enough behind the teaser to be out of sight, and two cut-out foliage borders—one hung down-stage and one half way back—are used to mask the view into the flies at the left.

Another simple exterior arrangement, which in this case makes use of a sky cyclorama instead of a drop, is illustrated in the floor plan for the turpentine grove Cleon Throckmorton designed for Act I of Paul Green's *In Abraham's Bosom* (Fig. 12). It is made up simply of a few frame tree trunks and a built-up bank of earth set up in front of a couple of silhouetted cut-out foliage drops (Chap. V, Sect. 16), all enclosed in a light blue sky cyclorama. Because no ceiling piece can be used in an outdoor scene, two cut foliage borders are employed to mask the flies from the view of the audience.

Four other typical arrangements of exterior scenes are given in Figure 11.

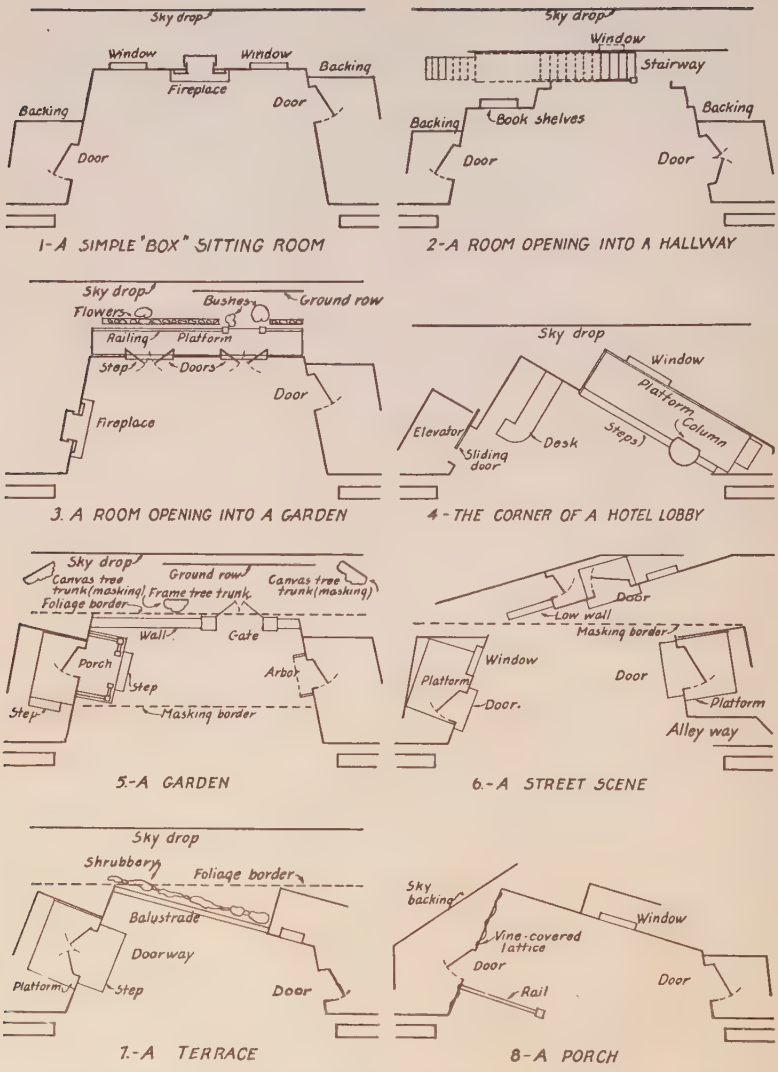


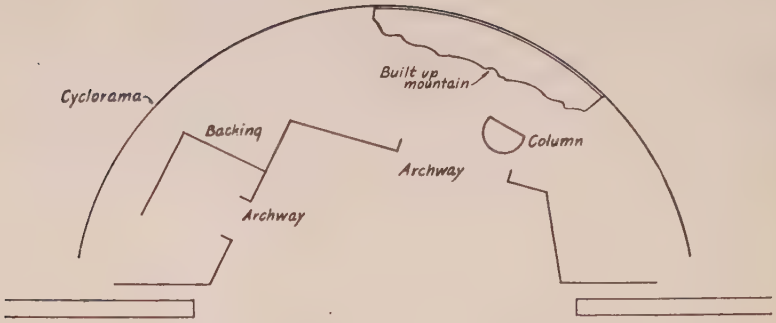
FIG. 11. FLOOR PLANS OF SEVERAL DIFFERENT TYPES OF INTERIOR AND EXTERIOR SETTINGS

7. Cyclorama Settings

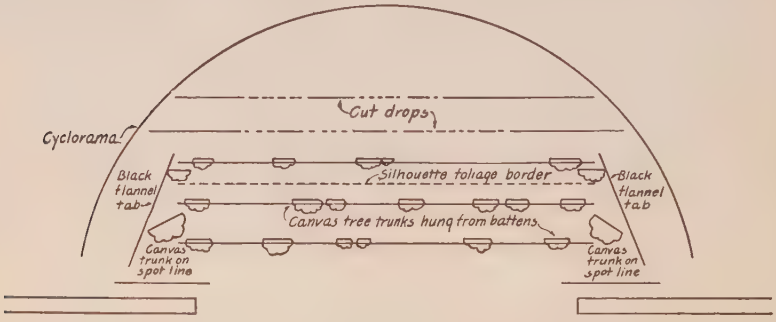
Certain classical and certain essentially poetical plays that do not require descriptive environments are frequently presented in neutrally colored drapery cycloramas (Ch. V, Sect. 12 and Figs. 13 and 36). Sometimes this type of cyclorama (different in construction, appearance, and purpose from the sky cyclorama described in Sect. 11) is used alone. More frequently certain built or set units are combined with it, to relieve its rather bare simplicity. The drapery cyclorama is hung from a U-shaped wood or steel frame suspended by two or more sets of lines, while the additional units, (if there are any) are secured in place in this setting independently, in exactly the same way that they are in a setting that uses flat and frame scenery alone. A border and two "legs" (Ch. V, Sect. 12) of the same material as the cyclorama are generally required to "mask" (hide from view) the top and side edges of the cyclorama.

A word might be said here about the advisability of the general use of draperies for setting the environments of a play. There is an unfortunate tendency in many non-professional theatres to over-work this type of scenery. Soft, neutral draperies often form very effective backgrounds for poetical plays of the distinctly formal or classical kind which demand more or less indefinite settings, but they are not suited for the more intimate and the more realistic types of plays, which demand definite characterization and atmosphere from their environments for the proper setting of their action.

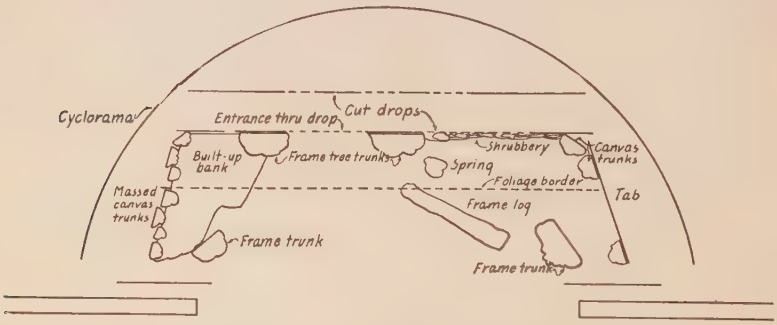
What is said here about draperies refers, of course, to the general use of this form of scenery in the set, not to its limited use. Draperies reasonably used may be combined with other forms of scenery to help express a wide range of environments.



FLOOR PLAN OF THRONE ROOM IN EMPEROR JONES"



FLOOR PLAN OF WOODS SCENE IN "EMPEROR JONES"



FLOOR PLAN OF WOODS SCENE IN "IN ABRAHAM'S BOSOM"

FIG. 12. FLOOR PLANS OF THREE SETTINGS WHICH MAKE USE OF THE SKY CYCLORAMA

The three settings were designed by Cleon Throckmorton for productions at the Provincetown Playhouse, New York.

8. Non-conventional Arrangements of Scenery

Descriptive interior and exterior frame sets and formal cyclorama sets of the types just explained may be said to be more or less "conventional." Certain settings, however, which the artist may have to design from time to time for plays of a distinctly stylized nature (Ch. I, Sect. 4), will be quite "non-conventional." For the arrangement of scenery of this individualistic type, little can be said about any "general tendencies" for the reason that there can be no consideration of a standard design. The planning of each new set usually presents problems of arrangement peculiarly its own. If the set is to be an interior, it may, or it may not, be designed to have surrounding walls and a ceiling. Place can be indicated by a grouping of the usual flats, door, window or fireplace frames and ceiling piece, or simply by a free standing archway, window or balcony rail, or merely by a suggestive arrangement of furniture placed in front of a large neutral-colored panel, an unlighted sky cyclorama or a black velvet curtain. If the set is an exterior, place may be indicated by an elaborate grouping of significant rock, foliage, or architectural shapes, or merely by a couple of suggestive platforms, tree trunks, or columns backed by the same type of cyclorama or draperies. A stylized scene may be designed out of

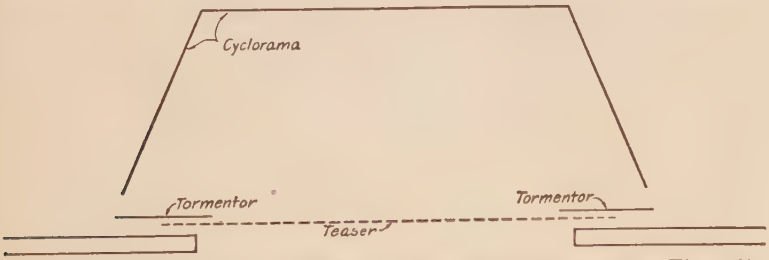


Fig. 13. The Plan of a Drapery Cyclorama Setting (See Fig. 36)

three dimensional units or two dimensional units. The whole scene may be done as a group of inter-related silhouettes or even painted quite flat, in the poster style, on a single screen or drop. Each setting of this kind requires quite clearly, therefore, its own particular arrangement of scenic units.

It is important that a set of the type described here be adequately backed and have its top and sides properly masked off. In the planning of obviously stylized scenes this requirement is generally met fairly easily. Because the scenery in such sets does not pretend to create an illusion of "real place," backings and maskings can be quite formal, that is, they may be treated frankly as themselves, with no attempt at disguise.

If no side walls and ceilings are used in the set, it is commonly backed by a blue sky cyclorama or a black velvet (or duveteen) cyclorama, while the sides and the top are masked (if the teaser and tormentors are not sufficient) by a set of plain or cut borders and a pair, or more, of returns, drapery legs (tabs) or the like. Frequently the down-stage edge of the set is framed off by means of an inner proscenium made up of a border and two returns or plain flats. Often the masking pieces for this type of set are cut and painted to lend interest to the principal design on the stage.

9. The Unit Set

Scenery, it has been stated, must be designed for easy and rapid shifting. This is an especially important consideration in setting plays of numerous scenes in which intra-act changes must be planned to cause the least possible interruption to the action. Some of the methods commonly employed to solve this problem are outlined in Chapter IV on the general construction of scenery and in Chapter VII on the assembling and shifting of

scenery. A word, however, might be said here about the use of the "unit set."

A unit set is an arrangement of scenery in which some or all of the pieces of scenery employed in one scene are designed to be employed again (in other combinations) in the other scenes of the play. In general, there are two kinds of unit set. A set of the first kind makes use of a permanent frame—representing, perhaps, certain sections of wall, banks of earth, rocks, or the like—which stands throughout the whole play, and in which insets (panels, alcoves, arch frames, window frames, etc.) are placed to mark the change of scene. The Theatre Guild has frequently made use of this trick in setting such elaborate productions as *Marco Millions,* and *Strange Interlude.* A large, permanent, architectural frame is erected on the stage, and the back and side walls of each succeeding scene, made into single panels by battening the unit flats together on the back, are set in and lifted out of this frame. Door and window frames are bolted into their openings so that time does not have to be taken even to place them.

In a unit set of the second kind the unit pieces of scenery used to form the background for one scene are simply reassembled to form another. This method of handling scenery is used constantly in the setting of Shakespeare. An archway and a group of steps used on one side of the stage in one scene are moved to the other side of the stage in the next; a plain, flat wall at the back is changed by giving it a jog up or down, or by taking out a couple of flats and putting in their place a two-fold with two small windows; or an interior is transformed into an exterior by taking out a section of the wall at one corner —pushing out the back wall at an angle and introducing a balcony railing backed by trees—and so on.

For certain kinds of play the advantages of the use of the unit set, wisely designed, is obvious. In addition to saving space and, at least to some extent, movement on the stage, it reduces the cost of constructing scenery, because certain parts are repeated. A warning must be given to non-professional artists, however, not to over-work this type of design. Unless one is very careful it is apt to degenerate into a plaything. The "Little Theatre unit set" has become somewhat of a joke for this reason. It is never really successful when the attention of the audience is called to the tricks being practiced on it. The spectator who is given the opportunity to play the little game of "let's see where the tall, pointed arch and where the three little windows appear next" is not going to give much notice to the acting. The designer who decides to work his ideas of scenery into a unit set must also be sure that this arrangement promises a real economy in shifting. A unit set of a rather bulky type recently placed in a small house on Broadway took three times the normal number of stage hands to shift and cost the management far more in the end than a full equipment of scenery handled in the ordinary way (see photograph opposite page 339).

10. The Problem of Sight Lines

One of the very first requirements of any arrangement of scenery is that it have good sight lines. Sight lines are the lines of vision to the setting on the stage from each spectator in the auditorium. A setting with good sight lines is one that is so shaped and so placed in relationship to the proscenium opening that the vision is good from all positions in the audience. If not the whole set of scenery, at least every feature that is important dramatically or pictorially should be well in view from every

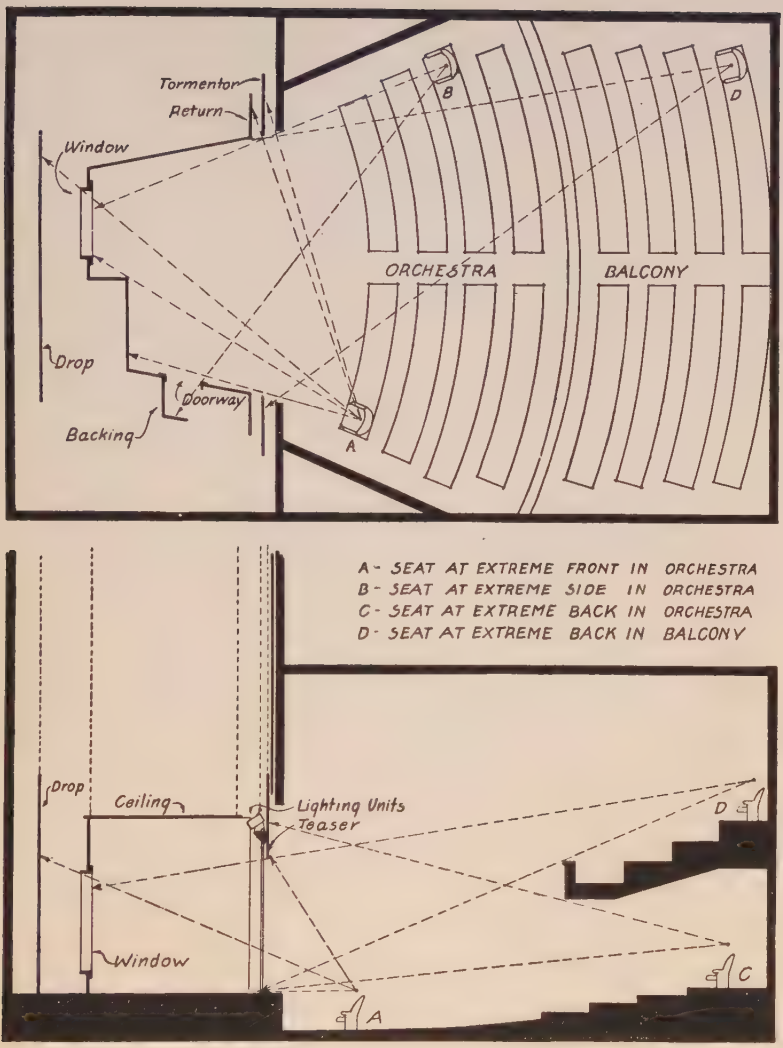


Fig. 14. Sight Lines

Good lines of vision to the stage from extreme positions in the auditorium require (1) the full visibility of the acting area and the chief features of its setting; and, (2) the adequate backing of door, window and fireplace openings in the setting, and the complete masking of lighting units and stage machinery—for every position in the house (except, occasionally, a few of the first row seats, if too close to the stage).

seat—the seat in the first row, the last row, and at the extreme side in the orchestra, and the seat in the first row, the last row and at the extreme side (if the theatre is reasonably constructed) in the balcony; as well as the seat in the ideal center of the auditorium. This means that the setting must not be so wide nor so tall that a part of it is hidden behind the edge of the proscenium; and it must not be so deep that the features at the back of the set are cut off from the view of the spectators at the sides or above. On the other hand, the setting must not be so narrow or so low that, in order to mask the down-stage edges of the scenery, the two tormentors and the teaser have to be set in to a position (Sect. 2) where they shield the view of the back parts of the setting from these same spectators.

When the artist works out the problems of good sight lines for various positions in the auditorium he considers not only how he may bring into view all that the audience should see, but also how he may hide all that they should not see—that is, the non-scenic part of back-stage. When he is dealing with the conventional enclosed interior he seldom has much trouble with the latter phase of the problem; the side walls of the set mask the wings and the ceiling masks the flies quite naturally. All that he must see to is that the teaser and tormentors are trimmed to hide the down-stage edge of the set all the way around, that the sky drop (if one is used), or other scenic pieces, are in a position to back up all exterior views of the scene itself, and that wall backings are in position to back up all interior views through doorways and other openings.

One point in the matter of arranging the down-stage masking of the top edge of an interior that the artist must never forget is the necessity for taking into account room for the electrical

units—border and spots—hanging just behind the teaser. As these lights must be placed just below the edge of the ceiling, and the teaser, in turn, must be dropped down far enough to hide completely the lights from persons sitting in the first few rows of the orchestra, it is clear that the height of the set must be planned to be eighteen inches to three feet more than that of the final trimming of the teaser.

When the artist is dealing with an exterior scene he is likely to run into considerably more difficulty than when he is dealing with an interior one; he cannot use in the exterior set the natural masking offered by interior walls and a ceiling. If the scene represents a street, a courtyard, or a garden set between houses, he has at his disposal some exterior walls, and his problem may be narrowed down to concealing the flies. In this case he will probably carry the walls and the sky (if one is used) so far up into the flies that with the help of a plan of illumination which keeps all light out of this part of the stage, the tops of the pieces of scenery will not be visible even to people seated in the first row. If this arrangement involves making the flats and drop too tall for practical construction and handling, the artist may have to hang in the flies (as much out of the range of the lights as possible) a couple of black borders—frankly theatrical masking pieces.

If, on the other hand, the exterior scene represents an open country landscape or a grove of trees, the artist may have to arrange his maskings without the help of walls at all. If there is enough room on the floor of the stage and the gridiron is sufficiently high, the artist will probably back the hanging or set pieces of his scene with a large sky cyclorama, or a plaster dome (see following section), which extends all the way around

and down-stage out of sight in the wings and away up out of sight in the flies. In front of this he can set anything he pleases —trees, fences, sides or corners of buildings, or distant mountains—with the comforting knowledge that from whatever angle the spectator may view the scene he will see sky beyond. If, due to limited space, however, the artist cannot count on the use of a cyclorama (or dome) and must limit himself to a flat sky drop, he must do some ingenious designing to cover the view into the stage wings. If he can possibly do so, he brings into his picture the side wall, or walls, of buildings—sheds, cottages, and the like—and supplies whatever deficiencies there may still be in maskings at the side by using closely packed tree trunks, green gauze tabs, rocks, banks of earth, or some other scenic pieces. The flies he generally masks by means of cut foliage borders (Ch. V, Sects. 11 and 16).

An ingenious arrangement of exterior maskings is illustrated in the plan for the country store scene in Figure 10. The view into the right wing is masked by setting the house on an angle and extending one of its walls into the wing. The view into the left wing is masked, partly by the side wall of an imaginary shed and partly by the sky, which for this purpose is dragged around at an angle by attaching a down-stage line from the gridiron to the upper batten of the drop (Ch. VII, Sect. 6). The view at the top of the scene is also fully masked; at the right, the front walls of the store extend up some distance out of view behind the teaser and so do not require any additional masking; at the left, the cut foliage borders mask the view into the flies at the side of the building.

The experienced artist reduces his problems of masking a great deal by using a selective system of lighting. He picks out

for illumination only the important scenic (and acting) areas and leaves the rest in shadow (Part Two, Ch. VI, Sect. 11).

11. The Sky

There are three pieces of equipment regularly employed to represent the sky on the stage:

First, a large suspended drop, painted a very pale blue (Ch. V, Sect. 11).

Second, a large suspended cyclorama, painted the same color (Ch. V, Sect. 12).

Third, the dome. This piece, sometimes called the "horizont," a German invention, is a permanent, large, convex wall of concrete or plaster, placed at the back of the stage and curved out into the wings and the flies. It is usually made in a form approximating a quarter sphere, but a little flatter at the back and with a sharper curvature at the sides and top. The perfect quarter sphere has been found disadvantageous to the acoustics of the stage. The dome also is painted a pale blue.

The reader may wish to ask which form of "sky" is to be recommended. The answer depends upon the size and shape of the stage on which one of the three pieces of equipment is to be used. The dome gives by far the best effect. It is absolutely free from wrinkles, and its curved, granular surface takes light beautifully, much better than even the best of painted canvases. The dome occupies, however, a great deal of valuable space on the stage. The edges often extend out into the wings and the flies in such a way as greatly to handicap the shifting of scenery on the floor and limit the usefulness of the fly system (see Ch. VII, Sect. 5). A full dome should never be built on a stage un-

less there is plenty of room for both it and the more standard equipment. Certain modifications of the dome, however, such as a very shallow, curved wall, may often be adopted for even limited stages. (Ch. VII, Sect. 2; see also *Modern Theatres,* by Irving Pichel.)

The cyclorama, if properly painted, stretched, and lighted, produces an effect of open sky nearly as good as that of the plaster dome; and it has the advantage, from the point of view of stage machinery, of being more flexible. If the gridiron is high enough, the cyclorama (or "cyc" as it is generally called) may be attached to two or more sets of lines, weighted with a U-shaped pipe at the bottom and, when it is not needed, flied up out of view. If the height of the grid does not permit flying such a tall piece of scenery, the cyc may be attached to lines at the top and fastened to floor hooks at the bottom in the manner described in Chapter V, Section 12, so that as soon as it has served its purpose it may be dropped, untied, and folded up. This last method of taking down a cyc takes time, of course, which means certain disaster if it must happen in the middle of a performance. The cyclorama is really practicable only on a fairly large stage.

For the restricted stage the drop is generally the most practicable. It cannot, it is true, give quite the same effect of depth of atmosphere that the dome (and, to a lesser degree, the cyc) can give; but if it is properly painted, hung, and lighted, it does pretty well. The drop is by far the most flexible of the three sky units; it can be flied straight up with one set of lines, tripped with two, or rolled up into no valuable space at all, in no more than a very few seconds. Also, the drop is the least expensive of the three units to build.

The methods of constructing the cyclorama and the sky are

described in Chapter V, Sections 11–12; the methods of painting these two units are described in Chapter VI, Section 19; and the methods of lighting the cyclorama, the drop, and the dome are described in Part Two, Chapters IV, Sections 5–6.

CHAPTER III

THE PLANNING OF SCENERY

1. Introduction

If the constructing, the painting, and the assembling of a group of scenic units to form the visual environment of a play are to be done effectively and efficiently, they must be carefully planned in advance. The laying out may be done in a variety of ways: by making a pencil, ink, or color sketch, by drawing a floor plan, or by building a small model of the proposed set. The process of evolving a scenic idea in the professional studio more often than not includes all three of these steps. The stage picture as seen in elevation through the proscenium arch by the audience is first visualized in a general way in an ink or color sketch; then the arrangement of walls, entrances, steps and other parts is worked out carefully in a floor plan; and finally the complete setting is checked from a three dimensional viewpoint by constructing it in miniature form as a scale model of wood or cardboard. The technique of developing scenery through these three steps, and the method of converting the completed plan into working drawings for the carpenter is outlined briefly in the following pages.

It must be realized that any general discussion of the problems of perspective in drawing and the effective use of pencil and water color media in sketching requires a great deal of space which could not be spared in this small book. For that reason the present chapter is limited to the consideration of a

few of the strictly mechanical aspects of designing. The reader who wishes to take up the general study of drawing and painting is referred to one of the books on the subject listed in the bibliography.

2. The Sketch

With the general design of his setting in mind, the artist usually attempts to visualize it first in the form of a sketch. Drawn in pencil or ink, and usually developed in water color,

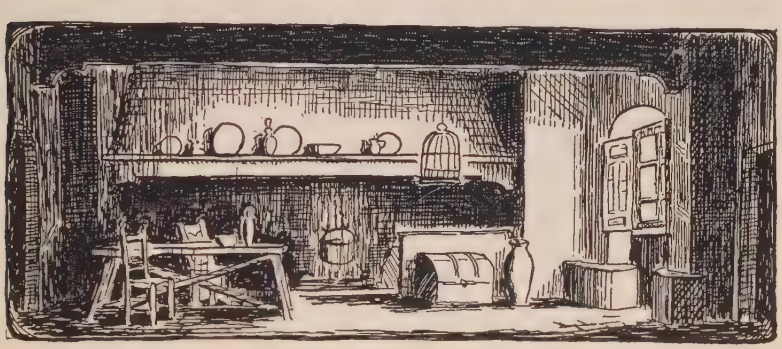


Fig. 15. A Pen and Ink Sketch for an Interior Scene
A design by the author for *High Spanish,* by George Spellman.

the "sketch" represents an ideal view of the projected scene as the latter would be seen from the front through the proscenium by a member of the audience. Offering, as it does, the best opportunity for the working out of the artist's ideas in line, mass, and color, it is on this step in the evolution of the setting that many designers spend their greatest effort.

One or two suggestions on the mechanical arrangement of the sketch are offered to those who are in doubt as to just what the drawing should include. Let the outside border of the

sketch represent the proscenium opening. Draw the set within this boundary as one would assume it would be seen by a person sitting in about the center of the auditorium, down stairs. Suppose the set to represent a simple box interior. From this position one would see the whole back wall, a little of each side wall (in sharp perspective), a very narrow strip of the floor and nothing of the ceiling.[1] As the teaser is always trimmed two or more feet below the edge of the ceiling, to accommodate the border light and spotlights (Ch. II, Sect. 10), the ceiling (unless it be made to slope down at the back) is never seen except by those sitting in the first few rows of the orchestra. This would obviously be a poor spot from which to design a scene. Figure 15 represents a rough pen and ink sketch for an interior scene. See, also, Mr. Robert Edmond Jones' and Mr. Ronald Jones' water color sketches opposite pages 4, 5 and 17, and other sketches on pages 7, 19 and 153.

One cannot emphasize too strongly the importance of keeping proportions accurate. If the maximum dimensions of the practical proscenium opening of the stage on which the scenery is to be set up are only 20′ x 12′, do not design a layout that would require an opening 50′ x 30′ to show the whole scene. Disappointment in the final staging of the scene, besides an endless amount of annoyance in the process of its creation, can be avoided only by strict honesty in the initial sketching. Never show in the drawing anything that cannot be made thoroughly real in production. Many of the so called "Sketches for the Stage" published in abstract books and magazines on the Theatre furnish illustrations of what not to do. Columns one hun-

[1] If the relationship of parts in a design is quite clear without their being shown in perspective, the sketch may be drawn in simple elevation (sect. 6), in which case the floor can be indicated by one straight line. See author's sketch on page 19.

dred feet high, gigantic screens, mountainous mechanical structures that would fill a whole city block, if made of actual wood and steel, may give inspiration for certain magnificent productions of the far future, but they are valueless as indications of what an artist may hope to re-create before an audience with the kind of equipment he has at his service today.

3. The Floor Plan

After the artist has worked out his inspiration first in the form of a general sketch, he develops his ideas further by making a diagram of them. The most valuable diagram he can use is the floor plan. The floor plan is a skeleton outline which shows the relationship of the walls, doors, windows, platforms, stairways, and other features that enter into the scheme of the scene, as these features would be seen from above, looking down onto the set. The diagraming can be done quite simply in a few lines. Floor plans of different scenes are shown in Figures 9–13.

If a floor plan is to be of practical value, it must be drawn carefully to scale throughout, and it must include the positions and dimensions not only of the main elements of the scene, but also of the incidental units, such as backings for the doors, set pieces seen through the windows, and, the larger properties, as well. The size and position of the proscenium opening and the placement of the tormentors in relation to the set should likewise be indicated. In this outline the arrangements for lighting the scene may also be blocked in (Part Two, Ch. VIII, Sect. 16).

An artist frequently plots his first rough ideas, as well as his later more matured ones, in the form of a floor plan. A simple outline helps him to organize his ideas before he works them out in his sketch.

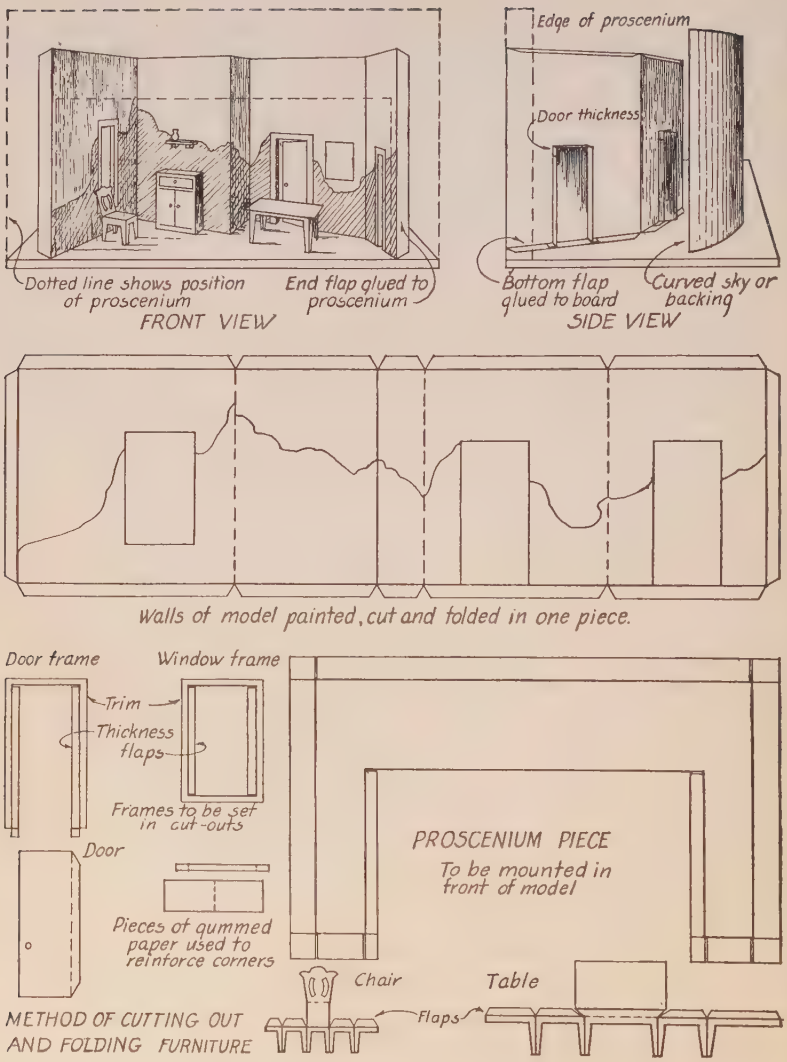


FIG. 16. THE CONSTRUCTION OF A CARDBOARD MODEL

The various pieces are cut out and folded forward on the dotted lines and backward on the heavy black lines. Scale about 1″ = 6″.

4. The Model

For those persons who possess a creative understanding of scenery, but who cannot draw in perspective, an excellent medium of design is offered in the "model." A model is a three dimensional miniature of a scene built carefully to scale out of wood, cardboard, or other material (Fig. 16). Many artists who develop their ideas in sketch form make use of this miniature also, either to check up on their plans before they lay them out in the final working drawing for the carpenter, or to demonstrate their plans to other members of the producing staff. The model is especially valuable to the artist who is required to submit in advance the scheme of a proposed setting to a director for his approval. A model usually presents a setting much more clearly and definitely than a sketch of the same scene.

The model is constructed most easily out of light cardboard. Two-ply bristol board with a finished surface for painting is excellent for this purpose. Eggshell board with a rough surface makes a better model, but is more difficult to work with. The model described below is of bristol board. The walls are first drawn out carefully to some definite scale such as $\frac{1}{4}'' = 1'-0''$ or $\frac{1}{2}'' = 1'-0''$. A scale of $\frac{1}{2}'' = 1'-0''$ indicates that $\frac{1}{2}''$ in the model represents $1'-0''$ in the actual stage set. When completely outlined, including door and window openings, the walls are cut out. This is done in one piece, if possible, because cardboard can be folded more easily than it can be fastened together. In cutting out the piece, or pieces, leave $\frac{1}{4}$ in. or $\frac{1}{2}$ in. flaps along all edges which must be joined with glue to other edges. Now, with the back of a knife or razor blade, score all lines along which folds are to be made. In each case score the cardboard on the side opposite to that of the crease. Fold the wall up and

mount it on edge, by means of the ¼ in. or ½ in. flaps on a piece of heavy cardboard or a wooden panel. If the glue does not hold very well, the joints may be temporarily held in place by means of thumb tacks or paper clips. Rubber glue is superior to the ordinary forms of glue for model making. Pieces of gummed paper strips, such as that used for binding packages in stores, are excellent for making or re-enforcing joints.

Usually the walls of the model are decorated before they are folded. Common water-color or show-card paints may be used for this purpose. Door and window openings can be made to look more real by inserting paper thicknesses (Ch. V, Sect. 6) into them to represent their door and window frames, and then fastening small door shutters or window sashes to the back edges of the thicknesses. Bits of furniture, folded out of paper and painted, add considerably to the effectiveness of the little set.

When the interior of the miniature has been finished, cut out a small proscenium to the same scale, paint it black, and mount it in front of the set as a frame for it. Place a light-blue sky piece at the back and add any foliage cut-outs or mountain rows called for in the final plan. If the walls of the model are made a little higher than the proscenium opening, no ceiling need be used. In fact, it is a good plan in any case to leave at least part of the top open for lighting.

5. The Working Drawings

The working drawings of a set of scenery are the building plans drafted for the carpenter. Laid-out to some selected scale—such as ¼″ = 1′–0″ or 1″ = 1′–0″—they show the exact dimensions and construction of each unit, and include indications of

materials to be used (if that is not apparent) and written explanations of all points that cannot be made clear by lines and figures alone. As the lines, however, are always more eloquent than the figures, words are employed very sparingly. If more than a dozen phrases are needed on any one sheet the plans are generally considered to be poorly done. Details, such as the plan of a difficult joint, an arrangement of moulding, or a special placing of hardware, are shown separately in enlarged detail drawings. Three dimensional units, such as stairs, and platforms are laid out both in plan and elevation (Sect. 6). Cross sections of units are added wherever they are necessary for clarity. As building principles on the stage are seldom complicated it is usually unnecessary to make drawings elaborate.

If the carpenter who is superintending the building of the scenery is a man of experience in the ways and means of the stage, it is, of course, a waste of effort to include in the working drawings all such details as the standard arrangement of parts in steps and parallels, of frame supports for columns and trees, or of joints and hardware on simple flats. Usually mere outlines of such units, with their widths and heights and the positions and sizes of any special features, like door or window openings, are all that are required.

A point in drawing flats should be noted. As the frames for these are constructed face downwards, the drawings are frequently done in reverse of the normal front view for the convenience of the carpenter. To save confusion it is wise to indicate which view of the flats is shown.

In general, make the complete drawing accurately to one scale. For this purpose the use of a scale-ruler, such as that employed by architectural and mechanical draftsmen, is quite essential. By accuracy we mean that a line on the paper 6″ long should

not vary from 6″ by more than 1/32″. If an enlarged detail is shown, write the scale immediately under it. The scale for the whole drawing should be placed in the lower right hand corner of the page. Check dimensions carefully several times and be sure that the sum of the dimensions of parts equals the over-all dimensions. If there is a discrepancy, the carpenter will probably toss up a nickel to decide which is correct. Small errors of less than an inch in the completed set will make it very difficult or impossible to put the set together.

Do not overcrowd a drawing with repeated dimensions, or with a mass of notes that obscure the outlines. If the drawing is clearly and completely drawn with all of the views and dimensions which are necessary, few notes are needed. Such a drawing will be easy to read.

For the benefit of those who are unfamiliar with the conventions used in the "mechanical" drawing of frame structures a few of the terms and methods employed are discussed in the following section.

6. Some Terms and Methods Employed in Drafting Construction Drawings

The shape and the construction of a frame structure (or any solid form, for that matter) may be conveniently represented on paper by three types of conventional views, called Elevations, Sections, and Plans (Fig. 17). An Elevation is a vertical view of the object of study, from the front, side, or rear, in which every element that is drawn is represented as being seen directly in front of the eye. No perspective whatsoever is used. The front elevation of a rectangular table would represent strictly the front face of it; one would see nothing at all of the top or the bottom

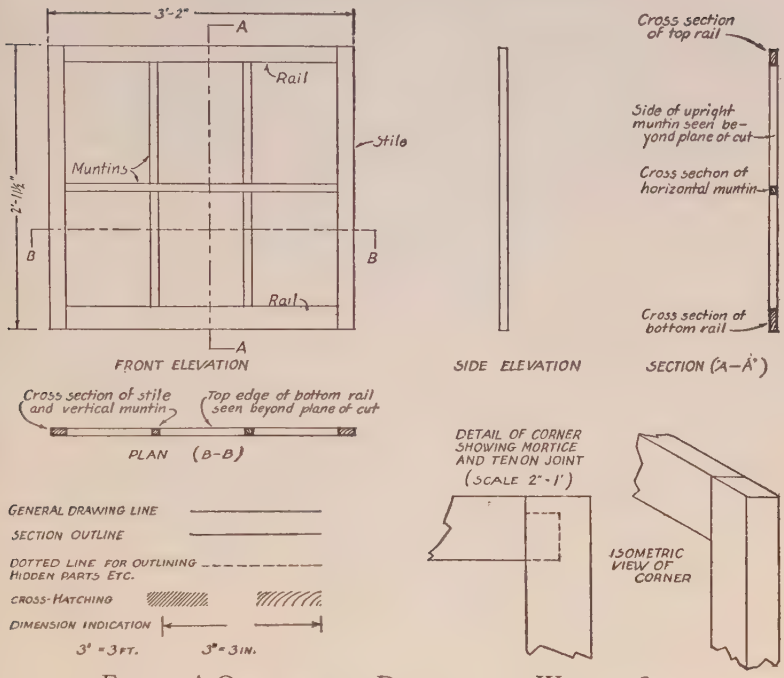


FIG. 17. A CONSTRUCTION DRAWING OF A WINDOW SASH

Showing the methods of drawing front and side elevations, a vertical section and plan, an enlarged detail, an isometric projection, section outlines, cross hatching of sections, and dimension indications. Scale ½" = 1'–0". This sash fits the double hung window shown in Fig. 28.

of the table-top. Nor, would one see anything of the rear legs (if they were of the same shape as, and were spaced equally with, the front legs), because they would be considered to be directly behind, and therefore hidden by, the front legs. The front elevation of a long avenue of trees planted on perfectly level ground, with all the trees of exactly the same shape and spaced equally from the center of the roadway (to take a conventional illustration) would show on each side only the first tree in each row. The house at the end of the avenue would be

represented as being seen, not far away, but as though it were at the same distance from the observer as the nearest trees. In other words, in an elevation drawing the element of depth or "thickness" is omitted. The front, side, or rear elevations of the window sash in Figure 17, the window frames in Figure 28, and the fireplace in Figure 30 show the object (from the particular side from which the view is made) as though it were perfectly flat. The purpose of this type of drawing for the carpenter, or any other craftsman, is obvious. It enables him to take accurate measurements from any part of the drawing without having to take into account any effect of perspective or distance. Unless it is specifically labeled otherwise, the "elevation" of an object is understood to be its front elevation.

A Section of an object is a cross-sectional view taken by passing an imaginary plane through the object vertically, horizontally, or longitudinally. The part, or parts, cut are outlined with a heavy black line, and filled in with cross hatching. Everything beyond the plane of the section (the cut) is shown in light lines. A typical section is illustrated in the drawing in the upper right-hand corner of Figure 17. Representing a slice taken down through the center of the window sash, it shows the cut ends of the meeting and bottom rails and the horizontal muntin, outlined and cross-hatched, and the side of one of the vertical muntins beyond, in lighter lines. Other typical section drawings may be seen in Figures 25, 28, and 43. When lines showing the positions of parts beyond the plane of the section —especially in section drawings of enlarged details (see section of ledge in Figure 18 and sections of door and window casings in Figure 29)—add nothing to the understanding of the drawing, they may be omitted. This is done frequently in the sketches

in this book. Unless it is specifically labeled otherwise, the "section" of an object is understood to be its vertical section.

A Plan of an object is either an outside view of the object looking directly down on the top of it (see plan of template in

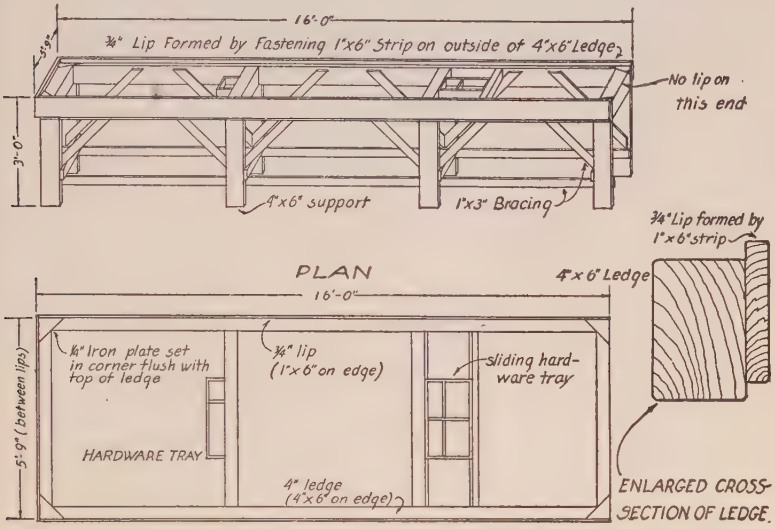


Fig. 18. The Template

A work bench for constructing flats and other frames in scenery.

Figure 18) or it is a horizontal section of the object (see plan of sash in Figure 17, of door frame in Figure 25, of window frames in Figure 28). One must be able to tell at a glance which type of plan is indicated in the drawing. In a horizontal section there should be heavy section outlines and cross-hatching (to show cut parts), in the plan representing an external view section outlines and cross-hatching would, of course, be absent. The "plan" of an object is most frequently understood to be its horizontal section looking down.

Approximately the position at which the imaginary plane is assumed to be passed through an object to give a section or plan view is generally clear enough when one compares the section or plan drawing with the elevation. If there is any danger of doubt, a light, broken line may be drawn across the elevation to show exactly where the cut of a section is made, turned at the ends to indicate the direction in which the section is assumed to be viewed, and lettered in some way to make clear what section drawing it explains. In Figure 17, for instance, the broken line A-A across the elevation explains the fact that "Section A-A" represents a vertical cross section view through the middle of the sash, looking to the right. The broken line B-B explains the fact that "Plan B-B" represents a horizontal cross section view taken between the horizontal muntin and the bottom rail, looking down.

Objects, or parts of objects, which can be explained more clearly in three planes than in one may be drawn in Isometric Projection. The difference between an Isometric and a true Perspective drawing is that in the former all parallel lines are placed on paper actually parallel to each other, without making them converge toward common vanishing points, as is done in the latter. Probably the most obvious example of isometric projection in this book may be seen in the three-plane view of a wagon unit in Figure 59. Other examples of isometric projection may be seen in Figure 18 and 25. If, in drafting, use is made of 30, 45, 60, and 90 degree angles as standards, isometric drawings may be done much more rapidly and accurately (from the point of view of the person who must read the drawings) than true perspective drawings.

The positions of concealed parts, when they must be shown, are commonly indicated by dotted lines (Fig. 17). Dotted lines

are also used occasionally (though not often) to represent the position of some part above or forward, or even sometimes back, of the plane of a section.

Dimensions are conveniently represented by double-headed arrows with the figures placed in the center of the shaft. A ′ is commonly used to represent feet and a ″ to represent inches; thus 2′ means 2 ft., 2″ means 2 in., 2′–2″ means 2 ft. 2 in.

In general, the drawings in this book conform to the conventions in drafting set down in these pages. In one or two instances the sketches have been made a little "unorthodox" in an effort to simplify them.

For a more extensive discussion of methods employed in the correct laying-out of working drawings and the efficient use of drafting instruments the reader is referred to any good book on architectural or mechanical drawing. (See Bibliography.)

CHAPTER IV

THE CONSTRUCTION OF SCENERY: GENERAL PRACTICE

1. Introduction

This chapter, devoted to the study of the general practices of scenery construction, is an introduction to the study of specific problems in the following chapter. Opening with a discussion of the practical demands of scenery construction, the following sections will consider in turn: the choice of tools; the selection of building materials; the procedure in construction; some methods of joining frames; the general method of covering frames; three systems employed to fasten units of scenery together; and the flameproofing of scenery.

2. The Practical Demands of Scenery Construction

Scenery constructed for the stage must fulfill a number of practical requirements.

First, scenery must be capable of easy and rapid construction. The plan of production most frequently adopted by both professional and non-professional producing groups allows from three to five weeks only for the complete preparation of a play. Within this brief period, frequently less, the stage designer, his staff and crew, must design, draft, build, paint, and fit to the stage usually two or three—commonly more—whole sets of scenery. It is absolutely necessary, therefore, that this scenery be planned

for the simplest and quickest possible methods of construction.

Second, scenery must be capable of economical construction. Unless great care is exercised the item of scenery on the final expense sheet of a production is apt to be a large one. It should be the purpose of the designer and his assistants, therefore, to keep down costs by choosing materials wisely, by adopting efficient methods of building, and, above all things, by avoiding waste.

Third, scenery must be capable of quick and silent shifting. That is, it must be constructed in light, well-shaped units which can be handled efficiently by a minimum number of stagehands.

Fourth, scenery must be strong. It must be able to resist considerable strain in the course of being handled by stagehands and actors, especially when placed in service for repeated performances night after night. It must be firmly put together and well joined.

Fifth, scenery must be well assembled. The methods of fastening together the various units must be such that it will be unnecessary to drive a nail during the performance. Nothing sounds more amateurish to the audience than hammering on the stage. The assembling and the taking apart of the units should be handled at all times quickly and silently.

Sixth, scenery must be capable of storage. It must be so designed and constructed that when it is not in use it may be packed away on the stage or in a store-room in a minimum amount of space. That is, large flat units, like drops, flats over 5′–9″ wide (Ch. V, Sect. 2) and ceilings must be capable of being rolled or folded; three-dimensional frame units, like platforms, must be collapsible; thicknesses on archways and other flats must be removable; and other bulky, awkward units, must be made either to be folded or to be taken apart in sections.

Scenery which is to be sent on tour and must be planned for storage in a crowded box-car must be constructed to fulfill the same requirements.

How the practical requirements of scenery construction here listed may be met is discussed in the following sections of this chapter, and in the next chapter.

3. Work Shop Equipment

For construction work the following hand tools are the minimum necessary:

Hammer
About a 12 oz.
Saws
Cross cut saw (for cutting across the grain)
Rip saw (for cutting with the grain)
Compass, or key hole, saw (for cutting curves)
Plane
2 inch
Screw Drivers
Ordinary solid screw driver
Spiral ratchet screw driver
Chisels
Several sizes
Brace and Bits
Most useful bits: $\frac{3}{8}''$, $\frac{1}{2}''$ and $1''$
Hand Drill
With $\frac{1}{8}''$ and $\frac{3}{16}''$ bits
Draw Knife
Files
Rasp
Clinching Iron
A flat piece of iron for clinching, or "bradding," nails

Squares
Steel Square
Try Square
Rule
6′ folding rule
Mitre Box
Steel or wood
Carpenter's Marking Pencil

These hand tools represent a construction carpenter's minimum equipment. Where quantity production must be provided for certain mechanical tools, such as a band saw, power rip and cross cut saws, jointer, and mortise and tenon machines, are helpful.

A work bench fitted with a vise is also necessary for good work.

Also, for securing accuracy and speed and the saving of many tired backs in assembling frames, the service of a *template* (Fig. 18) is a great help. A template is a stout, open frame bench, built waist high, the width of a standard flat (5′–9″), and 12′–0″ or 16′–0″ long, depending upon the average height of scenery to be made on it. The working part of the bench is a flat, narrow ledge of 4″ x 6″ lumber on edge, extending the length of both sides and the width of each end. Three 1″ x 6″ strips are fastened to the outside of the ledge on three sides to form a lip which will stand ¾″ above the surface of the ledge. In order to allow frames with a greater length than that of the bench to lie flat on the ledge the lip is not fastened to one end of the bench. If the whole bench is made absolutely level and square, scenery may be built on it without having to sight straight sides or test right angles. If the constructed frame lies well on the

ledge and fits snugly against the lip all the way around, the carpenter is assured that it is true.

Workshop equipment should also include, for gluing and covering purposes, a small gas, electric, or kerosene stove with at least two burners, several galvanized pails, and a couple of cheap 3″ or 4″ paint brushes.

In the following sections are listed the most useful materials for scenery building.

4. Lumber Materials

Because all frames must be light and strong, only particular grades of lumber may be used. Requirements of shop and stage demand that the lumber be soft enough for easy working, light enough for easy handling, yet tough enough to stand considerable strain and wear. It must not splinter readily, it must not warp, it must be straight-grained and free from any large blemishes, and it must be well seasoned. By far the best wood for general scenic construction is good grade Northern or Idaho *White Pine*. It is the standard. Sugar pine is the best substitute. In an emergency, Douglas fir, yellow pine, and certain other soft woods, may be substituted; but none of these can approach the efficiency of white pine.

For ordinary purposes, the lumber should be ordered in strips 1″ x 2″, 1″ x 3″ and 1″ x 4″ by 12′-0″ to 20′-0″ long, dressed and surfaced. The first two widths are used in building flats, the last in building ceilings, door frames, etc. In surfacing a strip at the yard about ⅛″ is planed off the thickness and about ¼″ off the width, making a so-called 1″ x 2″ strip actually ⅞″ x 1¾″, and so on. This makes no difference except that

proper allowances must be made in measurements during construction.[1] If the lumber man is obliging, he will prepare the strips with a thickness of $\frac{7}{8}''$, to accommodate theatrical hardware designed for it and, at the same time, with widths in even inches, to make the work of the carpenter easy.

To prevent waste one should choose the standard lengths in lumber which best suit the scenery to be built. If 14′-0″ scenery is to be built, for instance, strips should be ordered either in 14′-0″ or 20′-0″ lengths—neither 16′-0″ nor 18′-0″ would in this case be as economical. Each 6′-0″ piece cut out from a 20′-0″ length may be used as a top, bottom or toggle rail in the frame of a flat, where a piece 2′–0″ or 4′–0″ long would be useless.[2]

Above all things, in ordering, a carpenter must see that his lumber is absolutely straight. Flats with warped or crooked edges cannot be lashed together closely and cause an endless amount of annoyance.

Another useful wood material is 3-ply veneer board of basswood, whitewood (or other wood, preferably soft), called *profile board* in stage work. It comes in large sheets in several thicknesses (the most practicable of which are the $\frac{3}{16}''$ and $\frac{1}{8}''$), and is useful for all semi-rigid parts requiring lightness and toughness combined with flexibility. A strip of profile board can be bent into a fairly small circle without being cracked. It is employed to advantage in various kinds of light facings, such as

[1] Because mills vary a little in the amount of wood they remove in dressing a strip of lumber, this loss in width and thickness will not be taken into account at all (unless it is specifically stated otherwise) in the discussion of cutting lengths of lumber in this and the following chapter. That is, a 1″ x 3″ batten will be assumed, in the specifications, to be actually 1″ thick and 3″ wide. Each building carpenter, with the dressed size of his own lumber in mind, can make allowances wherever necessary.

[2] In the following Chapters the common term *batten* will be used as a synonym for strip.

risers for steps, curved backs of benches, ground rows, silhouettes, cut-outs, etc.

Nearly any cheaper composition board, such as *beaver board,* may be substituted where strength is not a consideration.

5. Covering Materials

Scenery is covered with either *canvas* or *muslin.* Flameproofed linen canvas is used in covering most professional scenery. It is strong, has more elasticity than other materials, and it takes paint well. It is, however, rather expensive. Good scene linen, 72″ wide, costs from eighty cents to one dollar per yard. Duck canvas, which is also very serviceable, costs about half that. Muslin, the cheapest of all, is rather flimsy and can be used to advantage on small frames only. Where expense is a prime consideration, however, and the pieces to be covered are not large, it works well enough. If necessary, two 36″ strips may be seamed together to make a 72″ width which will cost only about twenty-five cents per yard for the double width. Drill, also, is a good covering material.

Scrim, which resembles mosquito netting, is useful wherever gauze is required. It is woven in large widths and is generally dyed a dark blue.

Other necessary covering materials are:

Chicken wire (for frame trees, built-up ground, etc.)
Fish netting (for backing cut-out drops and borders)
Ground or flake glue
Cold water theatrical paste
Rosine (for attaching scrim or netting to drops and borders)
Rosine must be ordered from a theatrical supply house
Bolted whiting

6. Hardware Materials

The following hardware must be ordered from some theatrical supply house (see list of addresses at the end of the book):

Lash cleats—Small hooks on the frame of a flat over which a lash line is thrown to bind the flat to another
Lash line eyes—Metal eyes to which the lash line is attached
Brace cleats—Small plates into which stage braces are hooked to prop flats
Ceiling plates—Plates for bolting together and hanging ceiling frames
Hanging irons—Hardware for hanging scenery
Foot irons—Hardware for securing scenery to the floor
Stage picture frame hooks and sockets—Hardware for hanging or otherwise attaching light units to other units
Corner-blocks and keystones—Small triangular and keystone shaped pieces of $\frac{3}{16}''$ profile board used to reinforce joints

The following hardware may be secured from a local dealer:

Screws—No. 9 wood screws ($\frac{7}{8}''$ and $1\text{-}\frac{1}{2}''$)
No. 8 wood screws ($1\text{-}\frac{1}{2}''$ or $2''$)
Corrugated fasteners—No. 5 ($\frac{3}{4}''$)
Nails—Cement coated wire nails (4, 6, and 10 penny)
Finishing nails (assorted)
$1\text{-}\frac{1}{4}''$ lath nails
$1\text{-}\frac{1}{4}''$ clout nails
Tacks—No. 4 and No. 6 Tiffiny or carpet tacks
Hinges—$2''$ tight-pin back flaps (that is, each flap $2''$)
$2''$ loose-pin back flaps (that is, each flap $2''$)
$6''$ strap hinge (that is, each flap $6''$)
Bolts—$\frac{3}{16}'' \times 2''$ stove bolts
$\frac{3}{8}'' \times 2''$ to $6''$ carriage bolts with wing nuts
Door knobs and locks
Angle irons and flat corners braces—Assorted sizes

Pulleys—Assorted sizes
Sash cord—No. 8 (used for lash lines)
Soft steel strips—$\frac{3}{16}'' \times \frac{7}{8}''$ strips to be made into saddle irons

7. The Procedure in Construction

Before starting even the first steps in building, the whole plan of a set of scenery should be carefully drafted on paper. This plan is called the "working drawings" (Ch. III, Sect. 5) and is usually supplied to the carpenter by the artist who designs the set. It includes complete diagrams—plan, elevation, and, where necessary, cross sections and details—of each unit to show beyond any question the exact construction of every part. In order to prevent any possible waste of materials, time, or good disposition, caused by a completed set of scenery having to be cut over because the finished product does not check with the artist's original idea, a good carpenter demands to know in advance to the fraction of an inch just what he is supposed to do. If the carpenter is a man of experience, certain standard arrangements of joints, braces, and hardware may be omitted from the drawings, but enough detail should be included to make the plans clear.

(1) With the working drawings before him, the carpenter is ready to start. He checks them over and decides what materials are required. From stock he selects lumber of the right widths and thicknesses in lengths that will give the least waste. He examines each piece for straightness and absence of flaws. He sets the best pieces aside for use in parts that require the greatest strength and trueness, such as the stiles of a flat, while he places any slightly blemished pieces in another pile for making into toggle rails, cross braces, etc. Before cutting the lumber, he removes the raw edges (called appropriately by stagehands the

"curse") from each strip with a plane. This eliminates the great annoyance of splinters. A sixteenth of an inch is all that needs to be shaved off. This is done by running the plane the length of each edge once.

(2) The lumber is now carefully measured, marked, and cut. When several pieces of equal lengths are to be used, such as the stiles, rails, and corner braces of a series of flats, time as well as accuracy may be gained by cutting one piece for each dimension and using this piece as a model for marking off the rest, After all of one kind have been cut they may be piled together, as a last check, to make certain that all of them really are of the same length. That they be of the same length is important. It is difficult to conceive of anything much more aggravating than the discovery that a handsomely completed flat is just three and a half inches taller or shorter than its fellows.

If pieces of various dimensions must be cut and heaped together, penciled notations should be placed on each to provide ready identification later.

(3) The next step is the assembling. Each unit, such as the side of a parallel or a window frame, is considered by itself. The various battens that are to compose the frame are laid together in the proper arrangement on either a level floor or the template, the corners of the assemblage are carefully squared, and the parts are secured.

8. Jointing

The joint most commonly used on the stage--at least, in non-professional construction work—is the simple butt, or right angle, joint reinforced with a corner block or keystone (Figs. 19–20). The two pieces to be joined are placed squarely together,

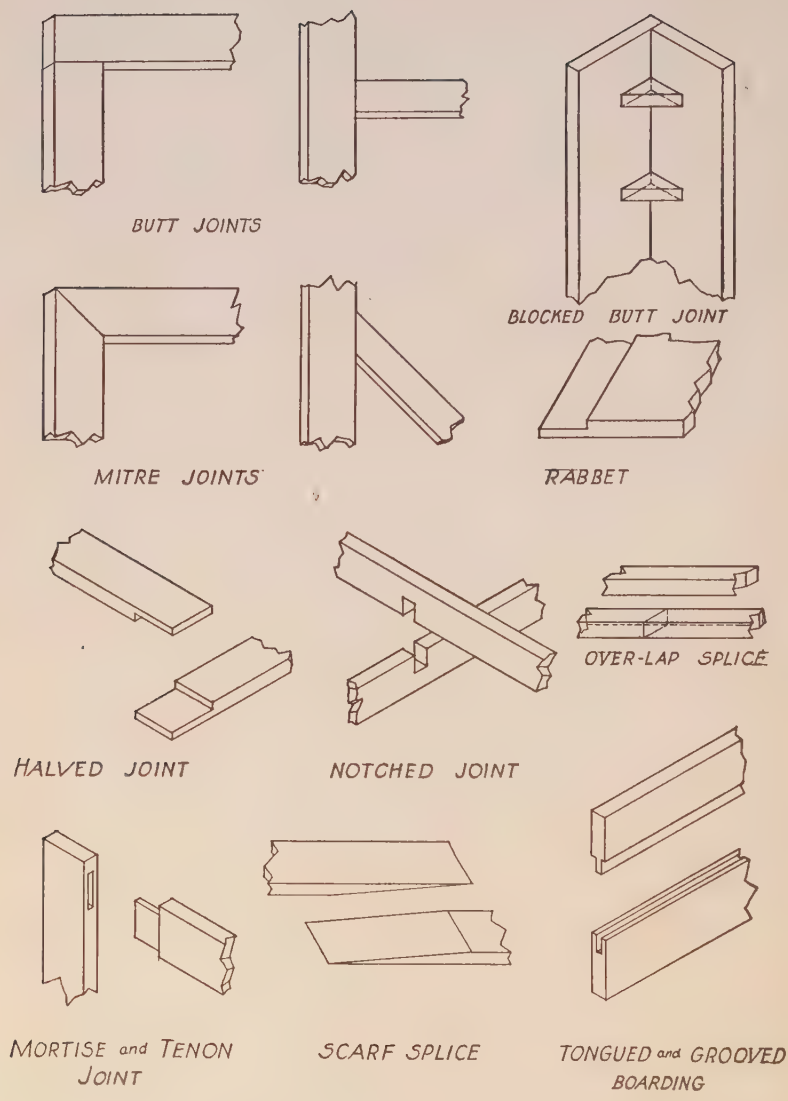


Fig. 19. Some Joints Commonly Used in Scenery Construction

one at right angles to the other, and two ¾″ No. 5 corrugated fasteners are driven in edgewise (teeth down), flush with the wood, across the seam. The corner block or keystone (small triangular or keystone shaped piece of 3/16″ profile board—(See Figures 20 and 23) is laid above this and secured by a number of 1¼″ lath or clout nails. As the combined thickness of the ⅞″ batten and the 3/16″ block is 1 1/16″, the extra 3/16″ of the point of the nail protruding through must be turned by holding a flat, heavy piece of iron, called a *clinching iron* against the under side of the batten while driving. The easiest method is to send

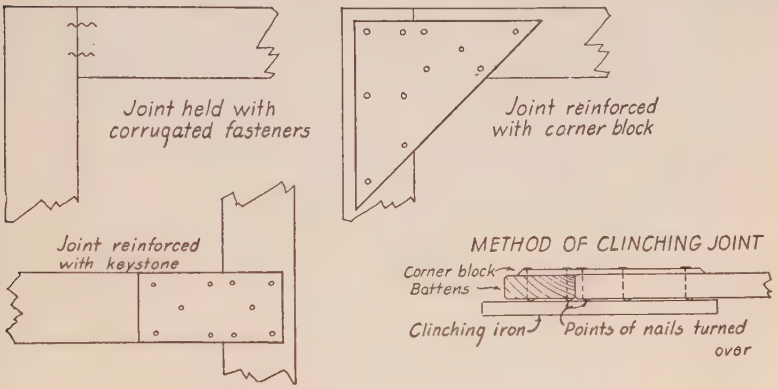


Fig. 20. Corner Block and Keystone Reinforcements

The profile plates shown here are of the smaller, "home-made" type. (See Sect. 8 and Fig. 23.)

all the nails part way in at first, while the frame is flat on the template, to prevent the parts slipping; then to lift the corner, place the iron underneath, and drive the nails in the rest of the way. If iron plates are built into the corners of the template, it is, of course, unnecessary to use an additional plate. The clinching helps to hold the joint rigid (Fig. 20).

Corner blocks and keystones should be set in ¼″ from the

outer edge of the piece of scenery to which they are attached to prevent any possibility of their being caught against the corners of other pieces of scenery in shifting. When the edge of one piece of scenery is butted up against the back of another piece the corner blocks and keystones lying in the way of a snug fitting should be set in $\frac{7}{8}''$, the thickness of the butted batten.

The reinforced butt joint makes a firm fastening, strong enough for most purposes on the stage. Some professional studios favor a mortise-and-tenon joint, in which a tongue (tenon), cut on one of the two pieces to be united, is fitted into a slot (mortise) in the other. A nail is driven through to hold the parts and a corner block or keystone added for reinforcement in the usual manner. As the strength of this joint depends on nice fitting it should not be attempted in the absence of proper tools. Under such circumstances a simpler method is preferable. A loose mortise and tenon combination is useless.

When special strength is required of certain types of joints, use may be made of a bolt, a small block of wood, an angle iron, a mending plate, or a steel corner brace. Special fastenings and reinforcements will be taken up in their proper places in later sections.

The regular corner blocks and keystones mentioned above are rather expensive when secured from theatrical firms. Substitutes can be made easily at home from $\frac{3}{16}''$ profile board or any other thin 3-ply veneer, soft if possible. Corner blocks should be cut in triangles about 8″ x 8″ and keystones in rectangles 6″ x 3″. Sizes may be varied to suit needs. Composition board, such as beaver board, however, because it is not very tough, is of little good for reinforcing joints.

Screws hold more firmly than nails. Where real strength is required in the types of joint which cannot be reinforced by cor-

ner blocks and keystones, such as those used to put door and window frames together, screws only should be used.

During the process of construction it is important to keep the frame absolutely square at all times. Corners should be tested frequently with the steel square. A flat that is even half an inch out of line will cause trouble when placed in the set.

(4) After the jointing is completed, a frame is ready for "covering" and the application of the lashing hardware. It does not make much difference which is done first, although the usual practice is to apply the hardware before covering (Sect. 9–10 and Figs. 21 and 22).

9. Covering

"Covering" is the term applied to the process of attaching a canvas face or surface to a frame. The method of covering a flat will be used to illustrate the steps in this process.

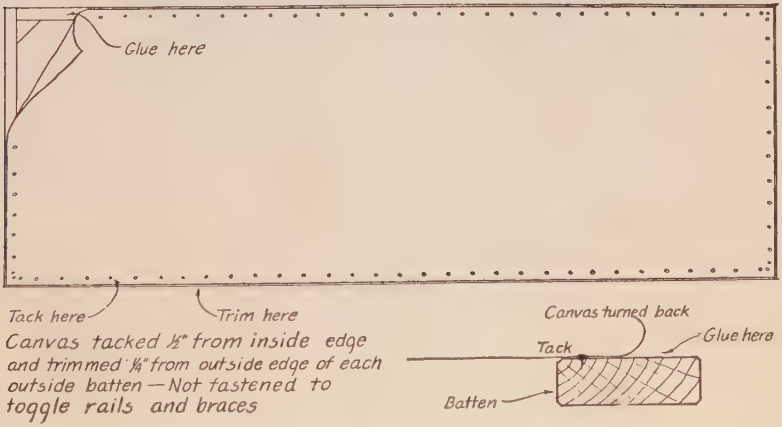


Fig. 21. Covering the Frame

The canvas is stretched, tacked and glued on the face of the frame, the other side from that on which the profile reinforcements and hardware are placed.

(a) Turn the frame over on its back so that the smooth side —that is, the side without corner blocks and hardware—is upward. Lay the canvas, or muslin, cut the proper length plus 2″ or 3″, over this. The frame is presumably 69″ (5′-9″) wide while the cloth is 72″ wide. Divide the spare, so that about 1½″ extends over the frame all around. Stretch the canvas and fasten it in position with four No. 6 Tiffiny or carpet tacks driven in, part way only, in the four corners.

(b) Now tack the canvas to the wood a half of an inch from the inner edge of the frame all the way around. Keep the cloth pulled evenly. A good plan is to tack one end first, and to walk to the other end and stretch the canvas from the first row of tacks while driving in the second row. Repeat this process on the sides. It is unnecessary to draw the cloth very tight in covering as the first coat of paint will shrink it somewhat. Do not fasten it to the toggle rail and the braces. Space the tacks about 6″ apart.

(c) Remove the four temporary tacks in the corners and lay back the loose cloth. If the canvas has been properly secured to the wood, there should be a free flap about 4″ wide all the way around. This is pasted to the frame. To prepare an adhesive agent for this purpose mix 1 pound of flake or ground glue in 2 quarts of water in a pail, and cook this on a stove until it is thoroughly dissolved. Be careful that it does not burn. When glue burns anyone two blocks away is aware of the fact. For safety's sake, it is well to put the vessel inside another containing a little water, in the double boiler manner, with a small block at the bottom of the latter to prevent the inside pail from touching bottom. When the glue has completely dissolved, stir 1 pound of whiting into it. Turn the flap of muslin on the frame back and apply the mixture, while it is still hot, evenly and

generously to the wood with an old brush. Do not place any over the edge; apply to one surface only. If the paste seems thin, let it dry for a moment before applying the cloth to it. Use the edge of a keystone and a rag, dipped into warm water and wrung out, to rub over the glued area, in order to make sure that the canvas sticks smoothly everywhere. Drive a couple of tacks into each corner, and trim the excess canvas with a sharp knife ¼″ inside the outer edge of the flat. This forces the cut edge into the wood, and prevents fraying when the set is handled.

Because wood does not take scene paint as well as cloth, all large wood surfaces, such as those on columns and steps, should likewise be covered with canvas. Brush the hot glue and whiting preparation over the surface to be covered, spread the canvas over it carefully, pull the canvas tight, rub it down, tack it down, trim the edges, and allow the glue to harden before painting.

10. Fastening the Units Together

There are three principal ways by which one unit may be fastened to another: (1) by a lash line, (2) by a loose-pin hinge, and (3) by a carriage bolt (Fig. 22).

(1) Flat, standing scenery, and occasionally tall built pieces, are tied together by the lash line method. This method makes use of a piece of No. 8 sash cord, called the lash line, and a series of small metal plates or hooks, called lash cleats, placed parallel to each other near to two adjacent edges. The lash line, attached to the upper right hand corner of one frame is tossed over the lash cleat placed a little below it on the other frame, carried over a second cleat lower on the first frame, and so on down to be tied off on two parallel cleats about 3′–6″ from the floor (Fig.

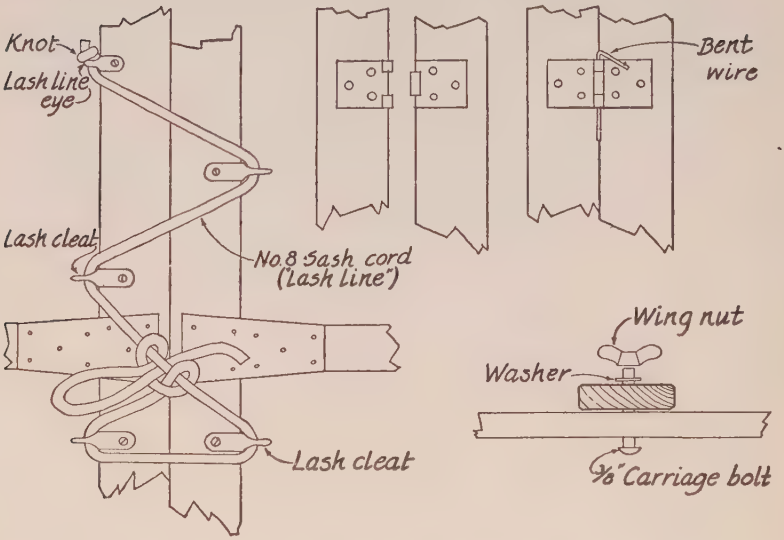


Fig. 22. Three Methods of Fastening Units of Scenery Together
Using the lash line, the loose-pin hinge and the ⅜" carriage bolt with wing nut.

48). If the knot is a bow, it may be quickly untied when the scene is struck (Ch. VII, Sect. 3). This method of lacing two flats or other large units together works very efficiently.

(2) Certain small pieces, as well as most of the heavier units, such as platforms and stairs, are fastened to each other by what is commonly called the "pin-hinge." The full title of this humble piece of hardware, however, is a "2″ loose-pin back flap." One half of the hinge is screwed to the edge of each unit and fastenings and unfastenings are made simply by inserting or removing the pin (Fig. 22). As the regular pin fits so snugly that it is sometimes difficult to put it in and take it out quickly, a short piece of heavy annealed wire (a little smaller than the

pin) is commonly used in its place. The top of the wire is bent over to prevent its falling through.

(3) Many structural units, particularly those designed to bear some weight or strain, such as stretchers, temporary braces for platforms and imitation beams, are fastened in place with ⅜″ carriage bolts put through holes bored in the frames to be joined, and drawn tight with a wing nut over a washer (Fig. 22).

Still another method is occasionally used to join together two pieces of scenery (see Fig. 44). This involves the use of a large stage picture frame hook and socket (or an angle iron and a flattened pipe strap). To maks the fastening, the hook, attached to one unit, is simply slipped into the socket attached to the other. This method, which makes neither a very tight nor a very strong joint, is really useful for hanging a light piece only, such as a false beam or a shelf, onto a wall or similar frame.

11. Flameproofing

Fire regulations in many communities necessitate making scenery flameproof. This may be done by painting all frames, before they are covered, with chemicals secured from the Antipyros Company, in New York, and using canvas already treated, which may be ordered from the same concern. If this is found to be inconvenient or expensive, scenery may be flameproofed at home by painting both cloth and wood with a 40 per cent solution of sodium silicate or a wash made up of the following, stirred well till thoroughly dissolved:

1 lb. Borax (Sodium Tetraborate)
1 lb. Salamoniac (Ammonium Chloride)
3 qts. water.

All these chemicals may be secured from a local drug store. So-called "flameproof" scenery does not have to be actually 100 per cent fireproof. The inspector is usually satisfied if a sample to which a match is applied for a second chars but does not blaze. There should be no live coals.

CHAPTER V

THE CONSTRUCTION OF SCENERY—SPECIFIC PRACTICE

1. Introduction

The number of possible scenic units to be employed in building up stage settings is, as we have said, very large. No attempt will be made in this chapter to describe the construction of all of them. The building plans of the several pieces outlined in the following pages are, however, characteristic of whole groups of others similar in purpose to them. Consequently, an understanding of the principles involved in the making of the units laid out in this chapter should make fairly easy the solution of most of the more common problems of construction not specifically analyzed here. Many of the more special problems also can be solved by applying the same principles.[1]

2. A Plain Flat

The height of a flat (Figure 23), which depends upon the size of the stage and the demands of the set for which it is designed, may be of practically any height (though seldom over 20′-0″), but its width is usually not more than the standard 5′-9″. This width has been found to be about the most satisfactory. It makes the flat easy to construct and cover, easy to handle, and easy to store (see Ch. II, Sect. 3 and Ch. IV, Sect. 2).

[1] For the method of reading construction drawings, if this is not clear, see Chapter III, Section 6.

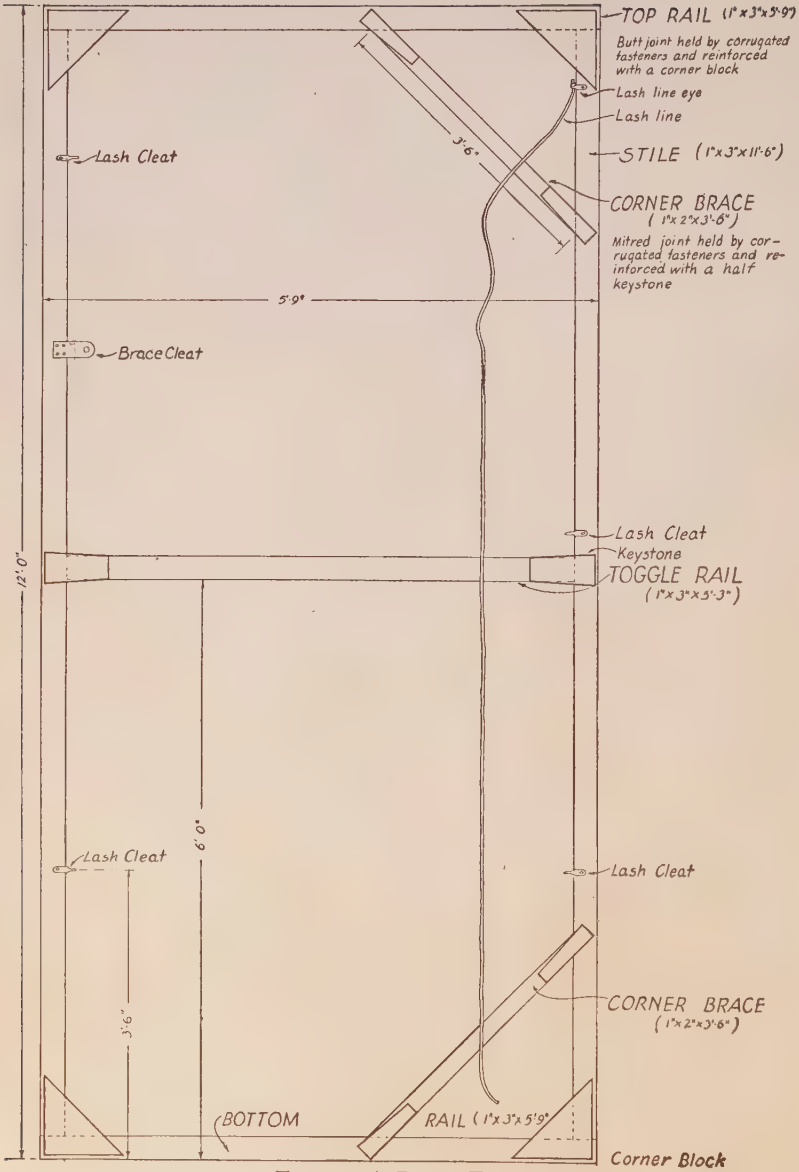


FIG. 23. A PLAIN FLAT

Rear elevation. The profile reinforcements shown here are of the larger "professional" size (see Ch. IV Sect. 8). Scale ½" = 1'–0".

For a flat 12′-0″ high, cut from white pine stock (Ch. IV, Sect. 4) the following:

2 battens	1″×3″	by	11′-6″	with square ends	(stiles) [2]
2 "	1″×3″	by	5′-9″	" " "	(top and bottom rails)
1 "	1″×3″	by	5′-3″	" " "	(toggle rail)
2 "	1″×2″	by	3′-6″	with mitred ends	(corner braces)

Place the first four pieces on the template or the floor and put them together in the form of a rectangle, with the two 5′-9″ rails lapping the two 11′-6″ stiles, as illustrated in the diagram. Making sure that the corners are absolutely square, first secure each joint by driving a couple of corrugated fasteners across the seam and then reinforce it with a corner block, in the manner described in Chapter IV, Section 8. Place the 1″ x 3″ by 5′-3″ piece (the toggle rail) between the stiles 6′-0″ from the bottom, and the two mitred 1″ x 2″ by 3′-6″ pieces (corner braces) in the upper and lower right hand corners. Secure the corner braces with corrugated fasteners but re-enforce with keystones (which fit better here) instead of with corner blocks. A somewhat neater job is done if all the corner block and keystone parts are set ¼″ from the edge. Also, if one wishes to take the time, the edges of the blocks and keystones may be beveled off with a plane. If one flat is to be butted up against the back of another, to make a corner, the corner blocks and keystones along one edge of one of the flats should be set back ⅞″ (the thickness of a batten) in order to permit making a snug joint (Ch. IV, Sect. 8). If the flat is over 12′–0″ high, one or more additional toggle rails will be necessary. Toggles in the frame should not be more than 6′–0″ apart. They may be less.

Apply the hardware. Place a lash line eye, or a screw eye with

[2] See footnotes at bottom of page 81.

a ½″ hole, in the upper right hand corner, a lash cleat just above the toggle rail on the same side, another one on the left side opposite a point half way between the first two plates, and two more, one on each side, 3′–6″ from the bottom of the bottom rail. If the frame is over 12′–0″ or 14′–0″, of course additional lash cleats are required. Attach brace cleats only to flats which need special propping up by stage braces, such as those occupying a position in the center of a long straight wall, or those holding door frames. In an emergency, 6-penny finishing nails may be substituted for lash cleats and screw eyes with 1″ holes for brace cleats. It is to be understood, however, that the use of this emergency hardware is distinctly a makeshift.

Cut a length of No. 8 sash cord long enough to reach from the lash line eye to within 3″ of the floor, put one end through the hole in the hardware, and knot it to prevent it from pulling through. The method of lashing two flats together is described in Chapter VII, Section 3.

When the hardware has been applied turn the frame over and cover it with canvas on the smooth side, that is, the side without corner blocks and keystones (see Ch. IV, Sect. 9).

3. A Paneled Flat

If a wall is to be paneled, a light skeleton is made into the back of each flat to give a footing to the moulding strips nailed to the face. Two toggle rails may be spaced to catch the upper and lower edges of a panel, while two upright 1″ x 2″ battens are set between these to catch the sides. If the panels are small and the moulding light, the vertical battens can be omitted and the moulding strips held snugly against the canvas by tack-

ing them from behind. If a cornice of any size is to be used, it must be built separate and be hung on, or bolted to, the flat, or set of flats.

Incidentally, if a picture or mirror is to be hung on a wall, a similar arrangement of batten support may be used. A 2″ toggle rail is set in the back of the flat high enough to catch the top of the picture. The latter is hung by fastening to it one or two stage picture frame-hooks (which may be secured from any theatrical hardware company) and slipping these into one or two corresponding sockets attached on the face of the flat to the supporting batten. If the bottom edge of the picture leans heavily against the canvas a second batten may be used to brace it.

4. A Jog, a Two-Fold and a Return

A jog, merely a narrow flat, is constructed in the same general way as the larger unit.

A two-fold, a combination of two flats, is hinged so that the members fold face to face. Three or more 2″ tight-pin back flaps are used to fasten the two frames together; and a 5″ strip of canvas is glued and tacked carefully over the crack to prevent light from shining between the flats when the two-fold is set up. A three-fold is built in the same way, except that an extra 2″ batten, called a "tumbler," must be hinged between No. 2 and No. 3 flat to allow the latter to fold over the edge of No. 1 when the combination is closed and packed away. In this way whole walls are often constructed in one piece.

The return is a two-fold in reverse. It may, if necessary, be made so that it can fold both frontward and backward by using two-way screen hinges.

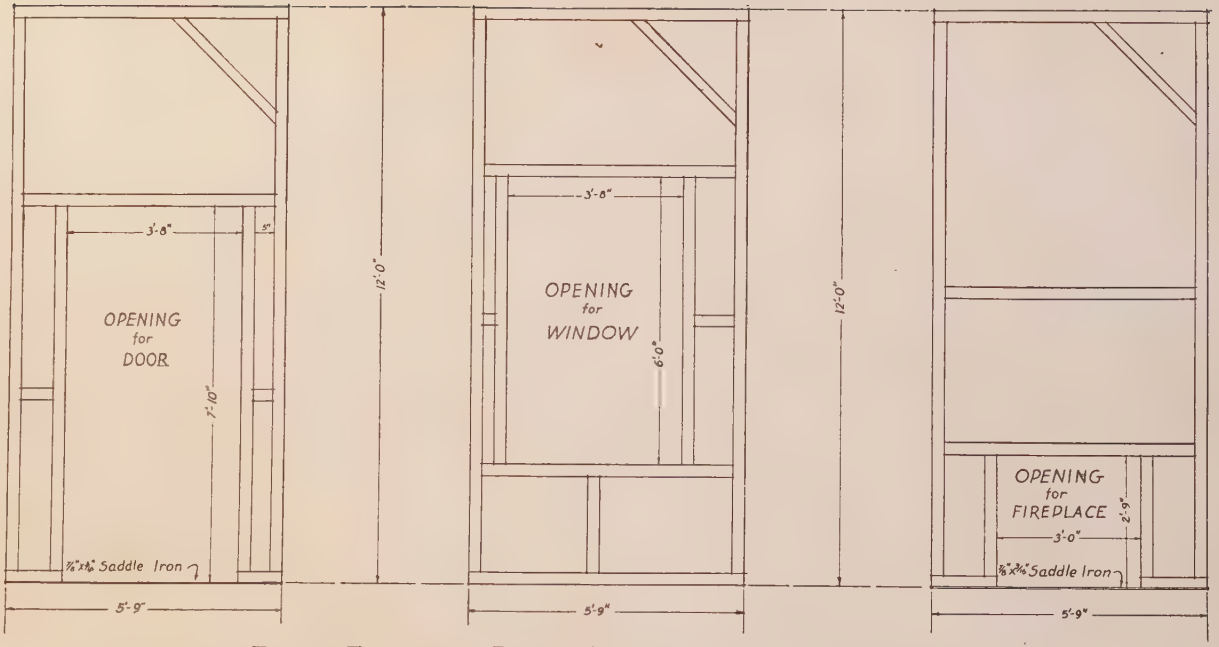


FIG. 24. FLATS FOR A DOOR, A WINDOW, AND A FIREPLACE FRAME

Rear elevation. All joints are reinforced with corner blocks and keystones. Scale ¼" = 1'–0".

5. Flats for a Door, a Window and a Fireplace

One method of treating doors and windows is to construct them of canvas and hinge them to flats as part of them. A second method is to build them separately of solid wood, like those found in any real home, and to clamp them, with their frames, into flats when setting the scene. Canvas doors and windows are less expensive, but solid frames are obviously more convincing in appearance. The latter not only give a reassuring and auditory impression of substantiality but also add interesting bits of modeling to otherwise flat wall surfaces. By reason of their being set back into the wall 4″ or 6″ they help to suggest that these, too, have thickness—a valuable aid to illusion. The flats illustrated in Figure 24 will accommodate either canvas or solid doors and windows.

The construction of these units is almost the same as that of plain flats, except that an inner frame is added. In the flat for the door the toggle is raised to form the top of the opening and two extra uprights are placed between this and the bottom rail. The part of the bottom rail between the uprights is cut away. In order to prevent the two legs from racking, a 5′–9″ piece of $\frac{7}{8}$″ x $\frac{3}{16}$″ soft steel, drilled and countersunk to accommodate No. 9 wood screws, called a saddle iron, is fastened to the bottom edge.

In the flat for the window one toggle rail forms the top of the opening, and another one, the bottom. Corner blocks and keystones have been omitted in the diagram (cf. Fig. 23) to permit the arrangement of the various joints being shown.

The flat for the fireplace (Sect. 8) is constructed like that for the door, but with a smaller opening.

In covering each of the three flats described above the canvas

is stretched over the entire flat and tacked, first around the outer edge, then around the opening. The center is finally cut out, and the flaps are pasted and trimmed in the way described in Chapter IV, Section 9.

6. A Door Frame Unit

A door frame unit (Fig. 25) consists of a solid "shutter" hung in a frame "casing," built usually of 1″ x 4″ to 6″ white pine stock and profile board. A section of the casing itself (Fig. 29) includes a box, or "thickness," the part that fits into the wall; and a facing, or "trim," parallel to the surface of the wall at right angles to the thickness. The door is set back in the casing, so that when the door is closed it shows the thickness; and the door is commonly hinged in such a way that when it is opened it swings off and up-stage.

Because the casing can be constructed to fit the shutter more easily than the shutter can be made to fit the casing, it is wise to build the shutter first. The most common form of door is the paneled one. It is made by fastening (by means of ⅞″ No. 9 screws) a sheet of profile board to the back of a light skeleton of 1″ x 4″ to 6″ stock, as illustrated in the drawing. The skeleton which represents the raised framework of the paneling should, if possible, be fastened together by means of mortise-and-tenon joints (glued and nailed without keystones). If tools for making this type of joint are not at hand, the 1″ x 4″ (to 6″) pieces may be attached directly to the profile board. Fasten each piece of the heavier wood to the veneer with a couple of nails, then turn the door over and secure all the pieces with screws. If the latter method of building a shutter is employed, be certain that the sheet of profile selected for the back is abso-

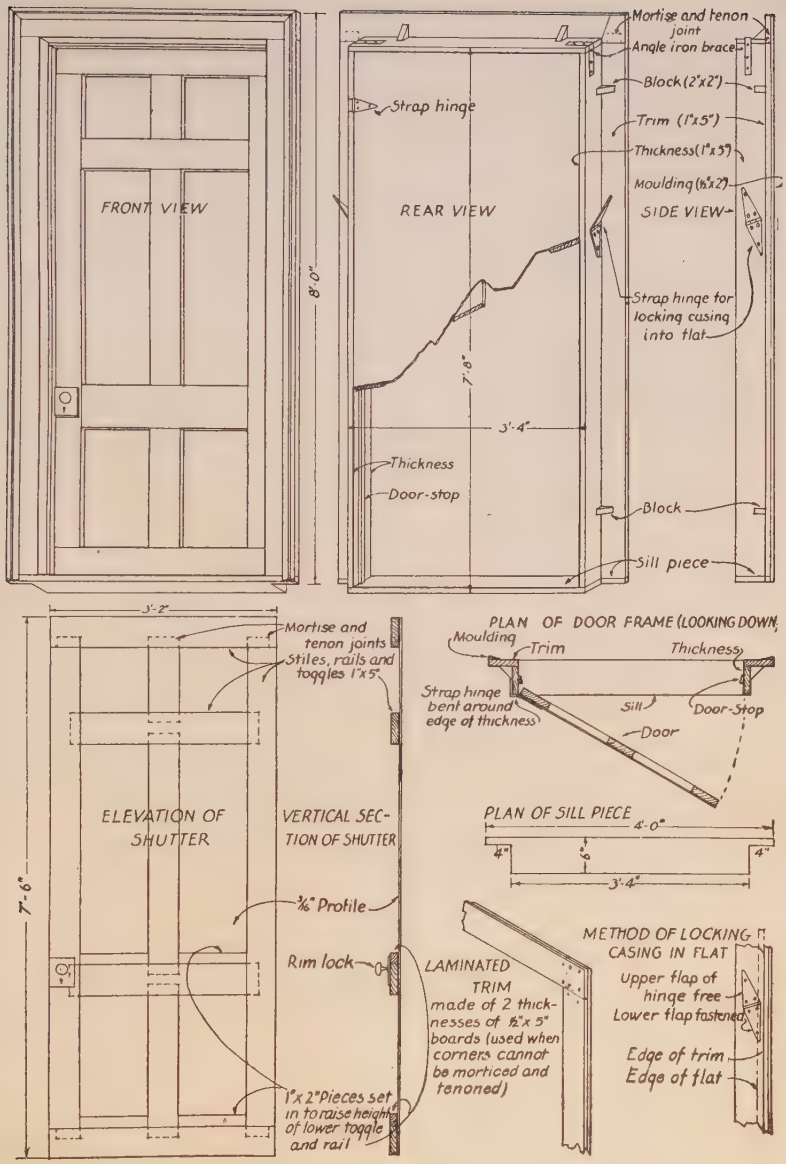


FIG. 25. A DOOR FRAME UNIT

Front, rear and side views, section and plan of the casing and shutter. Scale $\frac{3}{8}'' = 1'-0''$.

lutely flat, and heavy enough to keep the shutter hanging true. If a door of any size is to be made this way, it is wise to use wood of ⅜″ thickness, instead of the usual lighter profile. The construction of three other types of door shutters is illustrated in Fig. 26. Good ready-built shutters can often be picked up quite

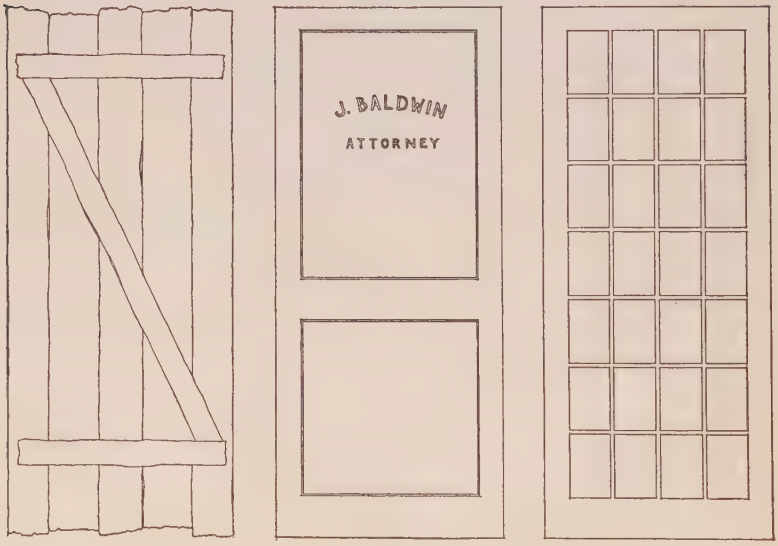


Fig. 26. Three Types of Door Shutter
Rough batten, office and French. Scale ⅜″ = 1′–0″.

reasonably at the lumber yard. The only disadvantage of stock doors is that, being built for long wear, they are apt to be heavy.

The casing, as has already been stated, is built in two parts—a "thickness" and a "trim." The thickness, made just large enough to fit the shutter comfortably, is constructed first. Cut out of 1″ x 4″ (to 6″) stock (or heavier if the door unit is to be large) three straight pieces for the two sides and the top, and a winged piece for the bottom. The width of the last piece

should be that of the others, plus the thickness of the trim. Put the four pieces together with right-angle box (butt) joints held by 1¾″ No. 9 screws. Wood splits very easily when long screws are driven into it. To prevent this from happening, first make a hole by using a hand drill with a ⅛″ bit or by driving in and drawing out a 6 penny nail, and then inserting the screw. The head and the sill should lap the edges of the jambs. The sill is attached in such a way that its extra width extends to the front. The trim is fastened with screws to the thickness, at right angles to the latter, all the way around except across the bottom. Its lower edges meet the two narrow wings on the sill. The latter is secured to the former by means of 1¾″ No. 9 screws put through from below. The sill piece (sometimes called the "saddle") will sit more steadily on the saddle iron of the flat into which the door frame is placed if a shallow groove is cut in the bottom of the sill.

Use mortise-and-tenon joints, if possible, for fastening together the three members composing the trim. If this cannot be done, build the trim out of two layers of ½″ stock, and lap the corners. That is, cut the three pieces for the first layer so that the two side pieces will extend the full height of the trim and the top piece will fit between them, and cut the three pieces for the second layer so that the top piece will extend the full width, and the side pieces will fit below it. Thoroughly firm corner joints will be obtained if the second layer is bound to the first by a number of screws or 1¼″ lath nails driven through and clinched on the under side (Ch. IV, Sect. 8 and Fig. 20). For further strengthening, a few 2″ x 2″, or larger, rectangular or triangular blocks may be placed in the angle formed by the meeting of the thickness and the trim.

The shutter is hung in the casing by means of two 6″ strap

hinges usually placed on the outside. One flap of each hinge is fastened to the shutter, and the other flap is carried over the edge of the thickness, bent, and attached to the side of the latter. Small strips of ¾″ x ⅜″ wood, called door stops, are nailed around the inside of the casing to prevent the door from swinging the wrong way.

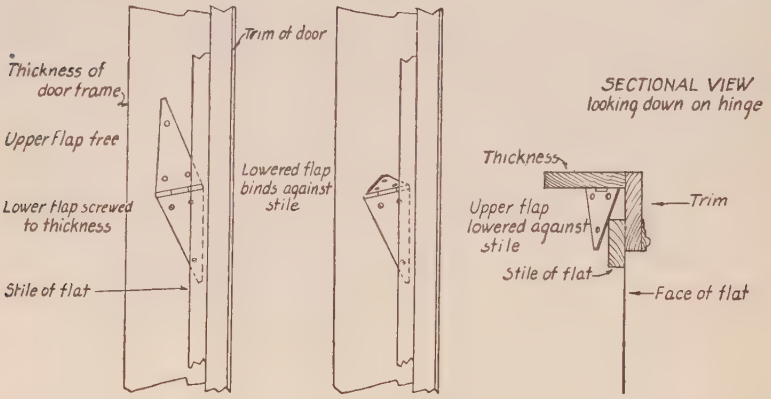


Fig. 27. The Strap Hinge Method
Of Locking Door, Window, and Fireplace Frames into Their Flats

The appearance of a door unit is usually very much improved by the addition of a little moulding.

Both door and window units are contrived to lock into their respective flats. To make this possible the 6″ strap hinge is again brought into service. One of these hinges is fastened to the thickness, part way up, on each side (Figs. 25 and 27). It is set at an angle, as illustrated, and only the lower flap is screwed to the wood, the upper flap remaining free. In setting the scene the free flaps are raised, the thickness part of the frame is put through the opening in the flat, and the free flaps of the hinges are lowered to bind the door and casing against the 1″ x 3″ up-

right battens of the flat. The trim, resting against the surface of the flat on the inside, prevents the frame from falling out.

In order to permit room for the strap hinges and the little triangular blocks of wood in the angle of the trim and thickness on the casing, and to make it possible to lift door and window frames out and in easily, the openings in the flats should be a little larger than the height and width of the thicknesses. Allow about 2″ clearance all the way around. That is, if the over-all measurement of the part of the door frame that comes through it is 7′–8″ x 3′–4″, the opening in the flat should be 7′-10″ x 3′-8″. If the little triangular reinforcement blocks are not used on the casing, a clearance of 1″ all the way around will be ample.

If a door unit is to be left in a flat through the whole of a performance and set or flied with the flat (as is often done), the door unit may be fastened in place by means of two or four ⅜″ bolts, (put through the trim of the door unit and the frame of the flat) instead of using the strap hinges.

A door unit should be well made. If it is loosely put together, it will sag after a little use, and the shutter will bind against the casing. A firmly constructed unit, on the other hand, will last for years.

7. A Window Frame Unit

A typical double hung window unit (Fig. 28) consists of two sash frames sliding between ¼″ x ¾″ and ¾″ x ⅜″ strips of wood (called a window stop and a parting strip) in a casing similar to that used with the door (See Figs. 25 and 29). The general plan of construction for both units is the same. Sash weights and other hardware are seldom used on windows. If one

sash must be raised, it can be held in place temporarily by means of a nail, or some other simple fastening. The construction of the sash for this window is shown in Fig. 17. Because real glass is

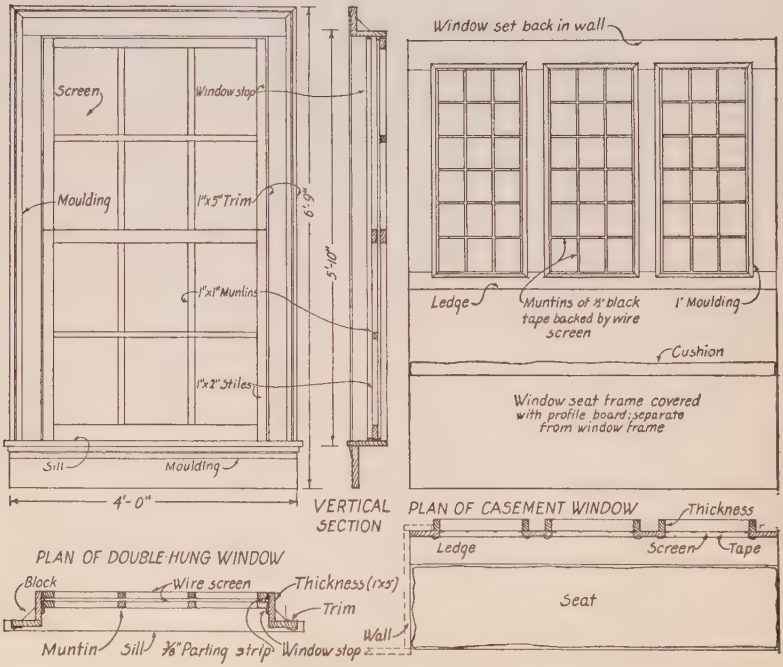


Fig. 28. A Double Hung and a Casement Window Frame Unit

Elevations and Plans. The construction of a sash for the double hung window is shown in Fig. 17. The ledge and the window seat for the casement window are constructed as a separate frame. Scale $\frac{3}{8}'' = 1' - 0''$.

shattered so easily, it is desirable to use in its place for panes galvanized wire screening tacked to the back of each sash.

The unit is said to be "practical" if it can be opened, "impractical" if it is permanently closed. The window casing is fastened

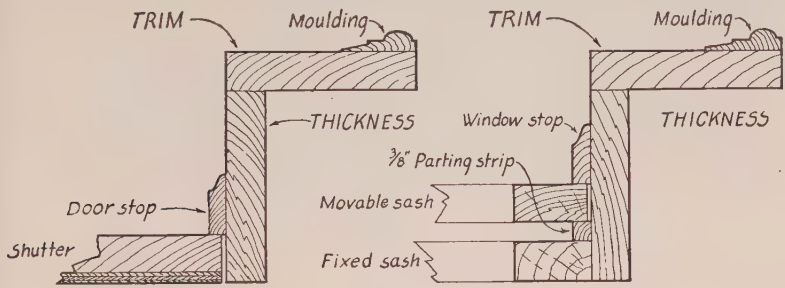


Fig. 29. Door and Window Casings

A comparison of the two jambs in cross section. Scale 1″ = 6″.

into its flat by either the strap-hinges or the bolt method described in the preceding section.

The construction of an "impractical" casement window with a separate ledge and window seat (a light covered frame), all placed in a recess in the wall, is suggested in the elevation and plan in the same drawing.

8. A Fireplace

A fireplace is constructed by nailing or screwing profile board over a light framework of 1″ x 3″ battens (Fig. 30). After a mantel cut from 1″ x 8″ or 10″ stock is fastened in place, the unit is dressed up with moulding and any additional woodwork desired.

The fireplace is used with a flat cut for it (Fig. 24). If the fireplace is of the type that extends out a few inches from wall, it will stand safely by itself, especially if its bottom is given a slight rake to incline it to lean backwards. If it is of the other type, however, such as the one pictured, it is safer to construct it with a 6″ permanent thickness, and to mount on the outer sides of

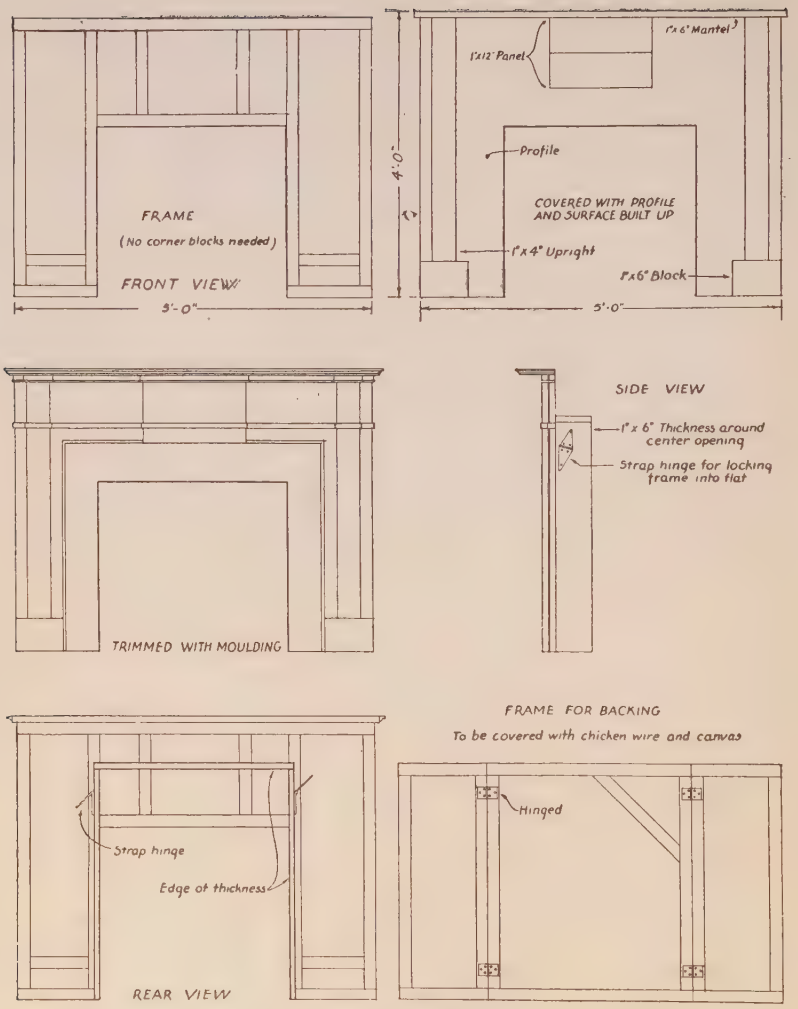


FIG. 30. A FIREPLACE UNIT

Showing the method of building it up from a flat frame. Also a hinged backing. Scale $\frac{3}{8}'' = 1'-0''$.

this two 6″ strap hinges, to clamp the frame into the flat in the same manner as door and window frames.

A small three fold screen daubed with gray and black serves as a backing for the opening. If the thickness described above is used, it must be painted to match this.

9. An Archway

An archway is made in four parts—a flat, a curved thickness-piece, and two side thickness-pieces. To build the first, two elements, called "sweeps," which together form a semi-circle, are cut from a wide 1″ board and inserted into the frame of a regular door flat as illustrated in Figure 31. The curved thickness-piece (often made in two parts as illustrated) is made up of two other semi-circles (or four quarter circles) held apart by light perpendicular blocks of wood. A strip of profile nailed to the sweeps underneath gives the upper face to the archway. Two 3″ battens, or wider boards, on edge, make the sides. To assemble the archway the curved thickness-piece is fastened to the flat with ⅜″ carriage bolts, and the side thickness-pieces to both the arched piece and the flat by loose-pin hinges.

A wider arch may be built in a two-fold. In this arrangement the saddle iron, holding the legs of the two flats, should be made to hinge in the middle. If the curved thickness-piece is too long for convenient construction or handling, it may be constructed in two or more parts and bolted together,

Without the service of a band-saw, the cutting of accurate sweeps is rather difficult work. A simpler, less "official" arch is illustrated in the lower right-hand corner of Figure 31. A square box thickness is fastened to the back of a rectangular opening in the flat, and the curve is created by merely bending and nailing

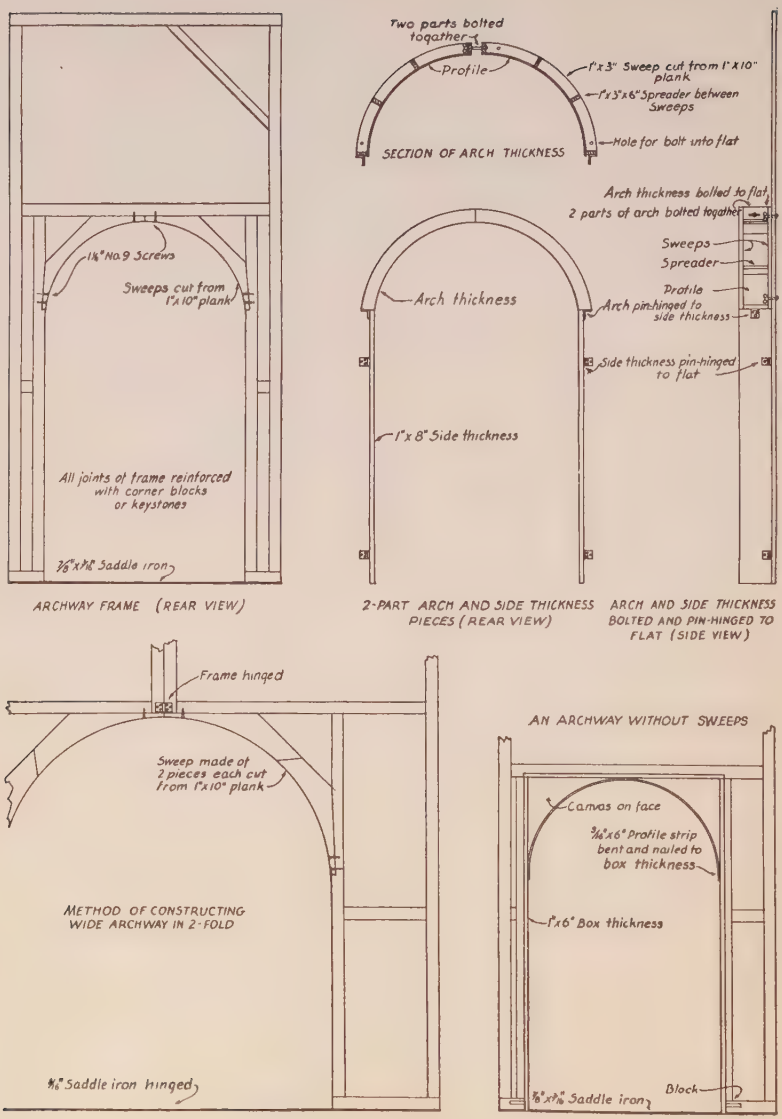

Two parts bolted together
Profile
1"x3" Sweep cut from 1"x10" plank
1"x3"x6" Spreader between Sweeps
Hole for bolt into flat
SECTION OF ARCH THICKNESS
Arch thickness bolted to flat
2 parts of arch bolted together
Sweeps
Spreader
Profile
Arch thickness
Arch pin-hinged to side thickness
Side thickness pin-hinged to flat
1"x8" Side thickness
1¼" No.9 Screws
Sweeps cut from 1"x10" plank
All joints of frame reinforced with corner blocks or keystones
⅜"x1½" Saddle iron
ARCHWAY FRAME (REAR VIEW)
2-PART ARCH AND SIDE THICKNESS PIECES (REAR VIEW)
ARCH AND SIDE THICKNESS BOLTED AND PIN-HINGED TO FLAT (SIDE VIEW)
Frame hinged
Sweep made of 2 pieces each cut from 1"x10" plank
METHOD OF CONSTRUCTING WIDE ARCHWAY IN 2-FOLD
⅜" Saddle iron hinged
AN ARCHWAY WITHOUT SWEEPS
Canvas on face
⅜"x6" Profile strip bent and nailed to box thickness
1"x6" Box thickness
⅜"x1½" Saddle iron
Block

FIG. 31. ARCHWAYS

A narrow and a wide "professional" arch with a detachable thickness, and a "home-made" arch with a permanent thickness. Scale $\frac{1}{4}'' = 1'-0''$.

in place a profile strip of appropriate width. A piece of canvas, on the face of the flat, is tacked to the toggle rail, brought down, cut and pasted over the edge of the profile. This archway is not always very true; and its thickness cannot be removed in striking, a disadvantage when the scenery must be packed; but where accuracy and portability are not so essential, it does well enough.

All solid wood pieces which are to be painted should first be covered with canvas (Ch. IV, Sect. 9). In the covering of a sweep the canvas should be split along the edge and each strip glued down separately, in order that the canvas may hug the curve.

10. A Ceiling

In old fashioned interiors the space above the wings or flats was masked by a series of vertical cloth strips called "borders." Modern practice, however, uses the more realistic ceiling piece to close in the set above. Attached to two or three sets of lines, it is raised and lowered horizontally.

The more common type for small stages is the "roll ceiling" (Fig. 32). Its construction is simple. A large sheet of canvas, made by sewing together several widths, with seams running lengthwise, is tacked and glued to two long 1″ by 4″ battens, one at the up-stage edge and one at the down. If the ceiling is to be of any length—over 20′-0″ or 22′-0″, say—each of these battens may be made of two shorter lengths spliced together with a scarf splice (Fig. 19). Three or more 1″ by 3″ battens, called "stretchers," cut the width of the ceiling minus 8″ (the combined width of the two longitudinal battens), are laid across between the longitudinal battens and bolted to them. A ceiling plate, one half of which is attached to an end of each stretcher

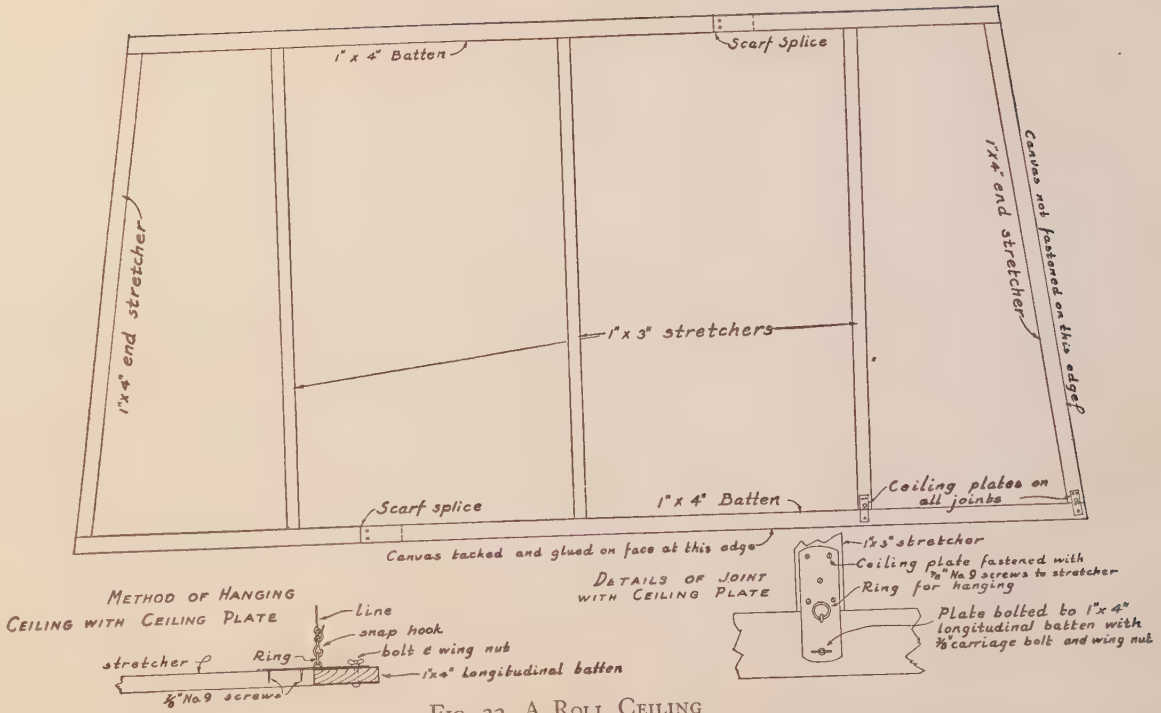

1" x 4" Batten
Scarf Splice
1"x 4" end stretcher
1"x 3" stretchers
1"x 4" end stretcher
Canvas not fastened on this edge
Scarf splice
1" x 4" Batten
Ceiling plates on all joints
Canvas tacked and glued on face at this edge
Method of Hanging Ceiling with Ceiling Plate
Line
snap hook
Ring
bolt & wing nut
stretcher
1"x4" longitudinal batten
⅜"No.9 screws
Details of Joint with Ceiling Plate
1"x3" stretcher
Ceiling plate fastened with ⅞" No.9 screws to stretcher
Ring for hanging
Plate bolted to 1"x 4" longitudinal batten with ⅜" carriage bolt and wing nut

Fig. 32. A Roll Ceiling

Plan, looking down from above. When the stretchers are removed this type of ceiling may be rolled up on the longitudinal battens. Very large or heavy ceilings may be braced on the back with two 1″ x 3″ stiffeners fastened to the stretchers by means of loose-pin hinges. Scale, ¼″ = 1′–0″.

by means of ⅞″ No. 9 screws (reinforced with ⅜₁₆″ stove bolts if the ceiling is heavy), laps the edge of the longitudinal batten and is fastened to the latter by a ⅜″ carriage bolt, which passes through a hole in the wood and is drawn up tight with a wing nut above the plate. Stretchers are not attached to the canvas. Therefore, they should be long enough to make a snug fit, and so prevent a sag in the cloth. The outer edge of this canvas at the sides can be fastened temporarily to the last two stretchers by a few tacks driven in part way.

If the ceiling is very wide, two stiffeners (1″ x 3″ battens on edge) may be pin-hinged across the stretchers to prevent sagging.

To fly the ceiling two sets of lines with snap hooks are lowered and attached to rings in the plates. When the frame is in use it is handled in a horizontal position. When it is not in use, one set of lines is detached and it is flied out of the way vertically like a drop. When the ceiling is to be carried on tour it is lowered, the stretchers are removed and the canvas is rolled up on the two long battens.

The "book ceiling," a type frequently used where the flies are full of hanging scenery and space is consequently precious, is nothing more than a double frame hinged in the middle and suspended on three sets of lines instead of two. If the ceiling is rigged in the manner suggested in Figure 33, it may be kept in a closed, vertical position in the flies till it is needed, then dropped and opened out on top of a set, by manipulating it from the fly floor alone, without having to lower it to the floor to attach the other set of lines—a distinct advantage when the stage is cluttered with scenery and properties.

Ceilings, both single and double, are often made with sloping sides instead of square, better to fit the shape of the top of the

usual interior set. The shorter edge, of course, is up-stage. If a ceiling piece is to be carried on the road, it must be so designed that it may be collapsed and packed into a small space, like the two above. If, however, it is to be used on one stage only, it is

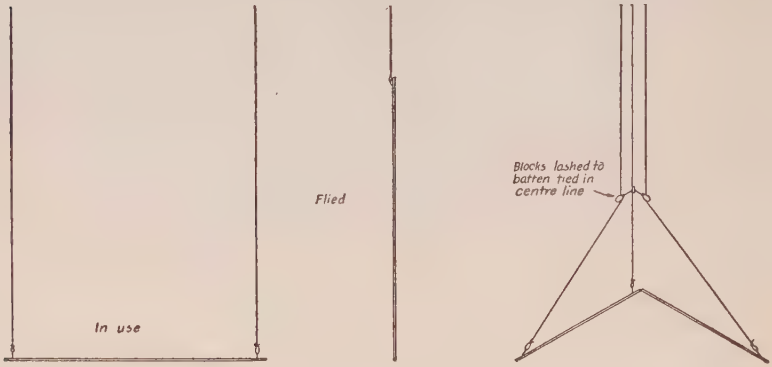


Fig. 33. Roll and Book Ceilings

The methods by which they are hung and flied. Side elevation.

unnecessary to make its parts detachable. The stretchers can be fastened permanently to the longitudinal battens, the canvas tacked and glued to the outer edges, and any type of simple hanging irons used in place of the more expensive ceiling plates.

Three virtues which should be found in every good ceiling are: lightness, tautness and size sufficient to cover the whole set (except the backings) comfortably.

11. Drops, Borders and Tabs

Drops (Fig. 34), if possible, should be made of good duck or linen canvas, not muslin, because the material must be strong enough to support itself without the aid of a frame. To prevent wrinkling in hanging, seam the cloth horizontally. Use single straight seams and keep all the selvage edges on the back. Tack

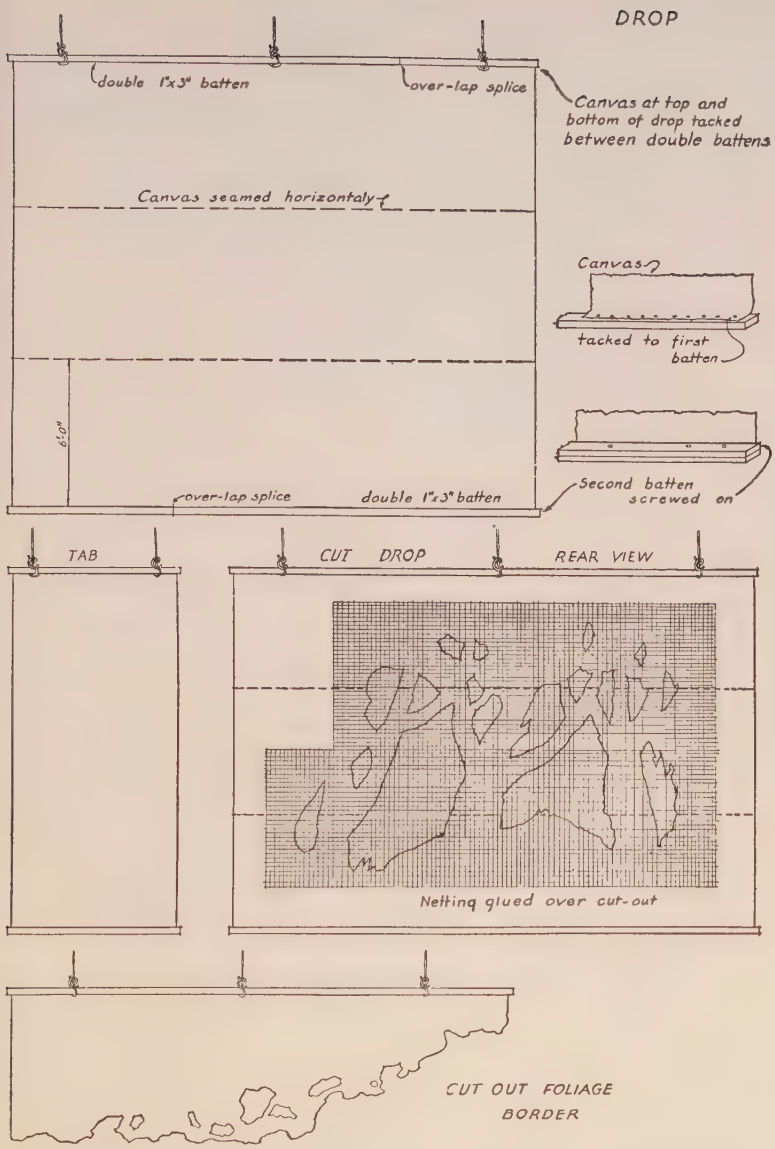


Fig. 34. Plain and Cut Drops, a Cut Border and a Tab

The units shown here are considerably smaller in scale than those generally in use on the professional stage. Scale, $\frac{1}{8}'' = 1'-0''$.

the cloth between double 1″ x 3″ or 4″ battens at the top and bottom, taking great care to avoid puckers. The battens are fastened together with 1¾″ No. 9 screws. If the wood strips are not long enough to reach the full width of the drop, they may be spliced with the usual scarf splice, or an over-lap splice (Fig. 19).

If a drop is cut, it should be backed by a large piece of netting or scrim (depending upon whether a clear or a misty effect is desired) which should extend over the entire open space and support the free branches and bits of foliage (or whatever the elements represent) that compose the silhouette. To attach the netting, turn the drop on its face and glue the netting to the back of the drop with some flexible adhesive agent. "Rosine," a preparation which is made especially for this purpose

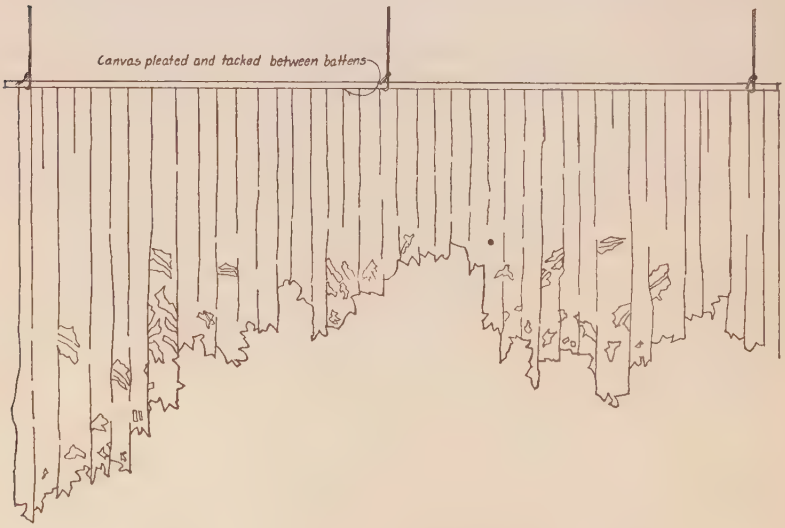


Fig. 35. A Cut and Pleated Foliage Border

Interesting effects can be secured with this type of foliage piece by draping one or both ends of the canvas. Scale, ⅛″ = 1′–0″.

and can be secured from any stage hardware company, is generally employed. It is melted for use in the double boiler manner described in the section on "Covering" (Ch. IV, Sect. 9), and applied with a brush. Some of the cold water pastes are fair substitutes. Whatever the agent is, it should be flexible enough not to crack when the drop is rolled. If the netting used is of the large mesh variety, it will be necessary to attach it to the drop by gluing little strips of cloth over the areas to be fastened.

Stretchers (Sect. 10) are sometimes used on the back of large drops to make them more rigid.

The border is made in the form of a shallow drop, commonly of only one width of 72″ canvas, with no battens at the bottom. Except as an occasional foliage or masking piece, the border is not used very much now and its name is often appropriated for other service. On a modern stage the simple term "border" is commonly used to refer to a striplight or row of spotlights hanging on a pipe batten overhead (Part Two, Ch. IV, Sect. 3). To distinguish it the canvas border is now commonly called a "cloth border."

The tab is made in the form of a narrow drop or border.

Drops, borders and tabs are flied by attaching sets of lines to their upper battens (Ch. VII, Sects. 6–7).

12. Cycloramas

Cycloramas, or "cycs," are made of a variety of cloth materials hung from U-shaped wood or metal frames. They are commonly wide enough to reach well beyond the tormentors into each wing, and generally high enough to require no masking above, other than that offered by the teaser and perhaps a

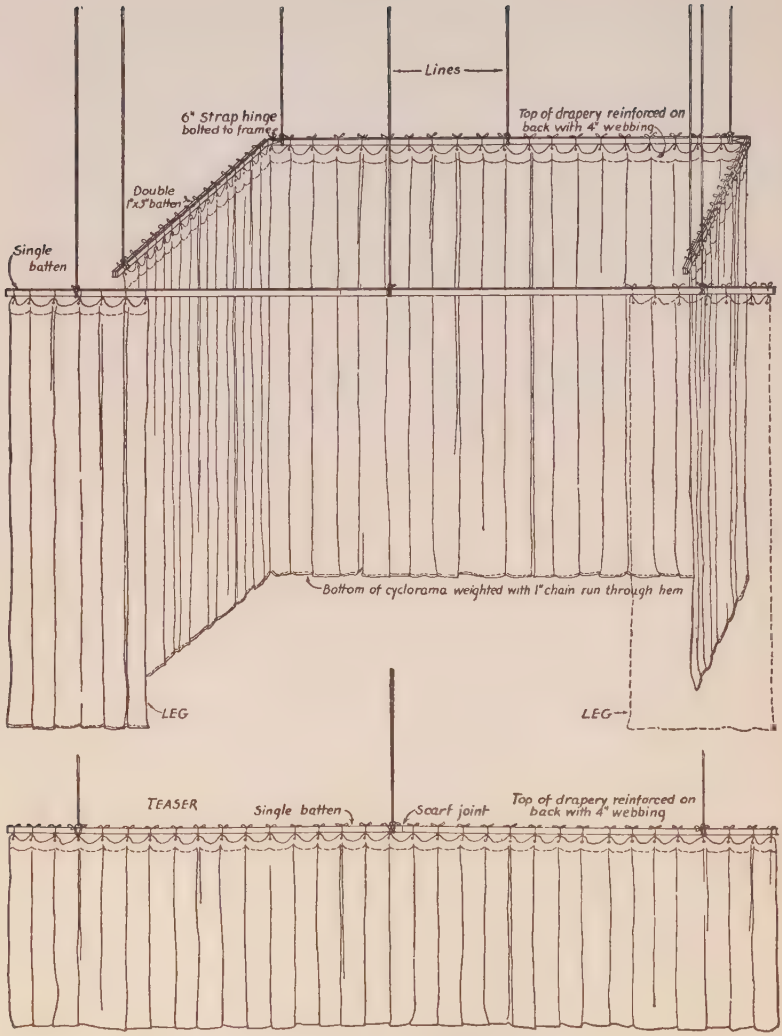


FIG. 36. A SMALL DRAPERY CYCLORAMA WITH TWO LEGS AND A TEASER
Scale, 1/8" = 1'–0".

border (Ch. II, Sect. 7). Made in several different forms, they serve a number of purposes.

The most common form is the drapery or curtain cyclorama (Fig. 36). The cloth material, usually a dyed fabric with a surface texture that takes stage lighting well—such as velvet, flannel, poplin, monk's cloth, silk, satin, or duveteen—is put together in vertical seams, reenforced with a strip of webbing at the top, and tied to the "cyc" frame by short cords which pass through grommeted holes along the webbed edge of the cloth. The grommets are placed 6″ to 12″ apart.

The frame itself is commonly made of three 1″ x 4″ battens single or double, depending on the reach and the weight of the draperies. A long batten supports the material at the rear, and

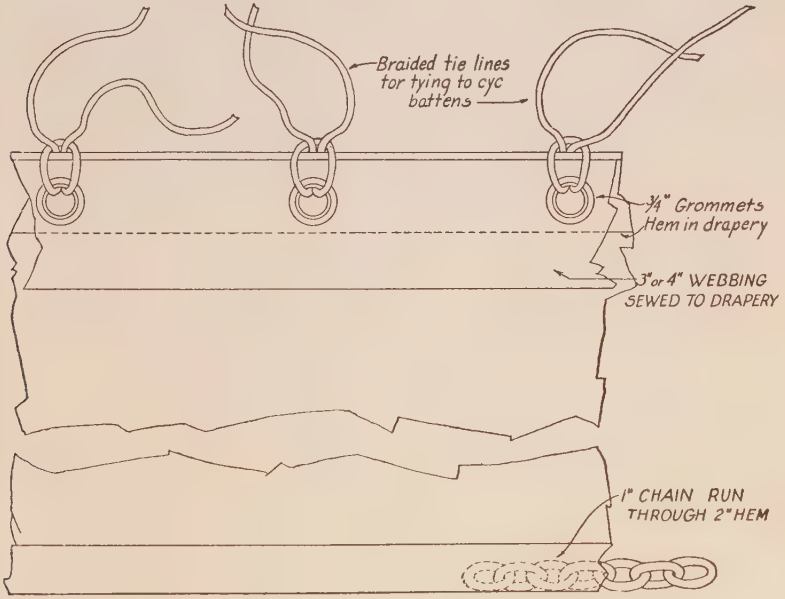

Braided tie lines for tying to cyc battens
¼" Grommets Hem in drapery
3" or 4" WEBBING SEWED TO DRAPERY
1" CHAIN RUN THROUGH 2" HEM

Fig. 37. The Methods of Reinforcing the Top and Weighting the Bottom of Cyclorama Drapes

two shorter ones, the "arms," pivoted to its ends with 5″ to 8″ strap hinges, carry the material down-stage and off.

As draperies are nearly always hung in folds, sufficient material must be ordered to allow for the gathering ("fullness"). —generally twice the total width of the cyclorama. The bottom should be weighted with about a 1″ chain run through a strong hem.

Gauze cycloramas, used in poetic and romantic plays, often in the Little Theatre and occasionally in the professional, are made according to the same plan as the more substantial forms. The transparent material is scrim (Ch. IV, Sect. 5) dyed a dark blue. Under the usual schemes of lighting scrim of this color succeeds better than that of any other color in "melting into the atmosphere."

A "sky cyc," used in place of the more common drop where it is advantageous to have an exterior backing extend around to the sides as well as across the back (Ch. II, Sect. 11), is made of wide strips of stout duck or linen canvas, sewed together in horizontal seams, and stretched tight between a wood or metal frame above and either another weighted frame, or floor hooks, below. This form of cyc, which usually must be expansive enough completely to hide its edges behind the tormentors and teaser without the help of any other scenery, is always a pretty heavy unit. Consequently, the frame to which it is fastened must be strong. The larger units are frequently hung from 1½″, or even heavier, piping in place of the pine battens employed for the smaller units. The canvas, which is webbed and grommeted along the edge, is laced with a long continuous cord, not tied, to the pipe. The bottom edge is similarly laced to a free, curved pipe, or, to "floor hooks"—which are frequently merely stage screws in the stage floor. When a strain is taken on the lines at-

tached to the upper frame the loose lashings above and below have a tendency to adjust themselves, equalize the pull, and thus draw out the wrinkles which often appear in even the best behaved cycs. A latitudinal strain is often added by lacing the vertical edges to snaphooks snapped over guide cables, which are stretched between the grid and hooks in the floor and drawn tight by turnbuckles. If wood battens are used to support a large cyclorama, the hinged corners must be strengthened and made rigid by diagonal metal braces bolted to the frame. If the braces are curved, they will also improve the shape of the cyc. Small cycs are sometimes hung from curved travellers (Fig. 4) which permits the cycs being pulled around out of sight when not in use.

If the down-stage edges of a cyc cannot be masked by the tormentors or other pieces of scenery, use may be made of two "legs" (tabs) hung in front of the edges of the cyc, parallel to the tormentors (Ch. II, Sect. 7).

13. A Platform Unit

A platform (Fig. 38) must be light and collapsible, but strong enough to support safely the maximum weight for which it is intended. If it is to be large, it is put together in a number of smaller, more portable parts, which may be assembled quickly in a performance to form the larger structure.

In unit form a platform consists of two parts: a "platform" proper, the floor piece on which actors stand and walk; and a "parallel," the light folding trestle which supports this. The construction of the parallel is illustrated in the drawing. Each of the five sections is made out of 1″ x 3″ white pine strips, cut and put together in the pattern shown. The parts are butt

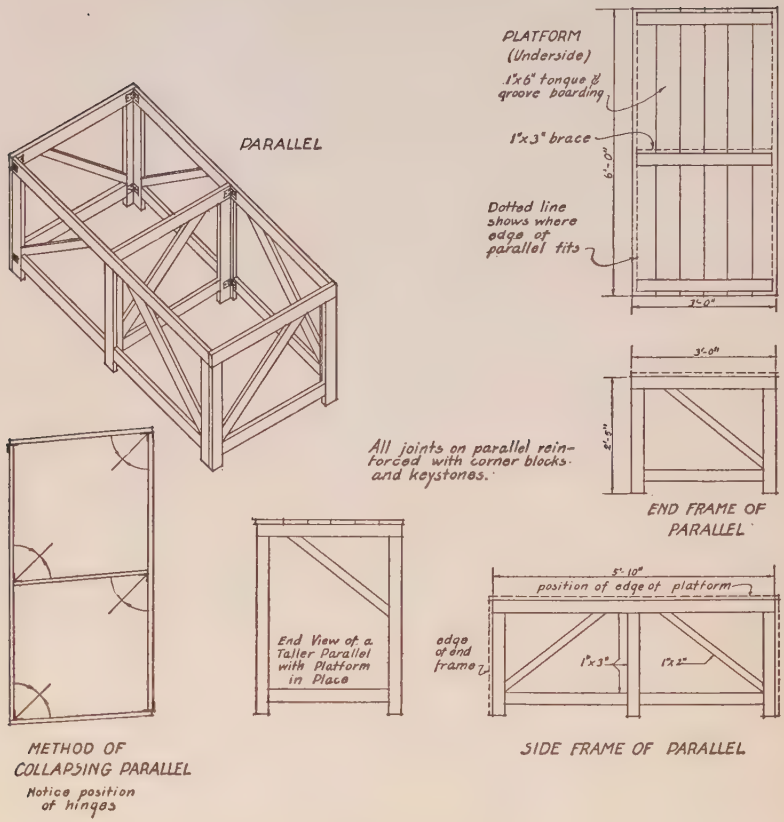


Fig. 38. A Platform Unit

Scale, $\frac{1}{4}'' = 1'-0''$.

jointed, fastened with $\frac{3}{4}''$ No. 5 corrugated fasteners, and reinforced with the usual corner blocks. Each frame is made rigid by a diagonal 1" x 2" brace in its upper right-hand corner.

The five sections are fastened together with 2" back-flaps, secured with $\frac{7}{8}''$ No. 9 screws, two hinges being placed at each corner. The two end sections overlap the edges of the side sections, in order to make square outside corners. With this ar-

rangement it is important that the hinges be placed as shown, otherwise the parallel will not fold. It should close one way only.

The top, or platform proper, is made of 1″ x 6″ tongue-and-groove stock held together by 1″ x 3″ cross battens fastened with 1½″ No. 9 screws. As the cross braces must fit inside the edge of the parallel, they should be cut so that they will be an inch shorter at each end than the width of the platform. Care must also be taken to see that the center brace clears the edge of the middle section of the parallel.

When two or more parallels are to be fastened together for mutual support, loose-pin hinges are used if the strain is not very heavy, and ⅜″ carriage bolts, if greater strength is required (Ch. IV, Sect. 10). To prevent a tall, top-heavy single platform from rocking over one or more legs of the parallel are secured to the floor by means of foot irons and stage screws, and it may be further strengthened, if necessary, by using a brace cleat and stage brace.

If one or more sides of a platform are to be in view of the audience, the visible face, or faces, of the parallel may be covered with profile board. This should be attached in such a way that it will not interfere with the folding of the parallel.

The inclined platform, or runway, called a "ramp," is constructed similarly to the platform just described.

14. Steps and Stairs

The principal parts of a simple flight of stairs are: the "stringers," the parallel planks which support the steps; the "treads," the horizontal boards that form the steps; and the "risers," the vertical boards that connect the treads.

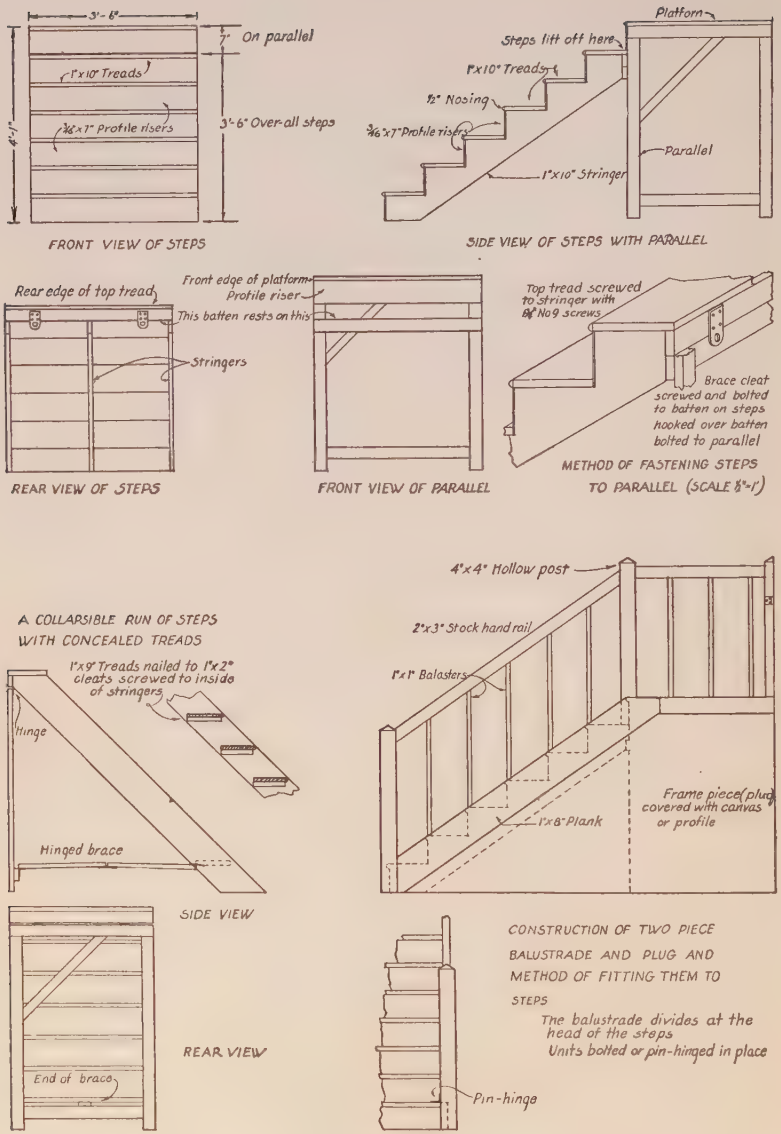

3'-6"
7" On parallel
1"x10" Treads
3/4"x7" Profile risers
3'-6" Over-all steps
4'-1"
FRONT VIEW OF STEPS
Platform
Steps lift off here
1"x10" Treads
1/2" Nosing
3/4"x7" Profile risers
Parallel
1"x10" Stringer
SIDE VIEW OF STEPS WITH PARALLEL
Rear edge of top tread
Front edge of platform
Profile riser
This batten rests on this
Stringers
REAR VIEW OF STEPS
FRONT VIEW OF PARALLEL
Top tread screwed to stringer with 8# No 9 screws
Brace cleat screwed and bolted to batten on steps hooked over batten bolted to parallel
METHOD OF FASTENING STEPS TO PARALLEL (SCALE 3/8"-1')
A COLLARSIBLE RUN OF STEPS WITH CONCEALED TREADS
1"x8" Treads nailed to 1"x2" cleats screwed to inside of stringers
Hinge
Hinged brace
SIDE VIEW
REAR VIEW
End of brace
4"x4" Hollow post
2"x3" Stock hand rail
1"x1" Balasters
1"x8" Plank
Frame piece (plug covered with canvas or profile
CONSTRUCTION OF TWO PIECE BALUSTRADE AND PLUG AND METHOD OF FITTING THEM TO STEPS
The balustrade divides at the head of the steps
Units bolted or pin-hinged in place
Pin-hinge

FIG. 39. STEPS

Stationary and collapsible runs of steps, a balustrade and a plug. Scale, $\frac{1}{4}'' = 1'-0''$.

Figure 39 shows a common method of construction. Each step is made by nailing a 1″ x 8″ to 12″ tread across two or more stringers cut from 1″ x 10″ stock, in such a way as to allow about an inch of the front edge of the tread to overhang the step below. If the step is over 30″ wide, one or more additional stringers are placed between the outside two. Risers, because they are required to bear no weight, are made of $\frac{3}{16}$″ profile. There is no absolute standard for dimensions of steps. Their height and depth depends on the pitch required of a flight of steps. The amount of 17″ is frequently employed, however, as a standard over-all measurement of a tread and its adjacent riser; that is, if the tread is to be 12″ deep, the riser will be 5″ high, if the tread is to be 9″ deep, the riser will be 8″ high, and so on.

A flight of stairs, unless it is supported independently, is made to fasten to the platform to which it leads. A 1″ x 4″ batten is fastened with 1¾″ No. 9 screws across the stringers at the top, under the edge of the last tread, and a similar batten is placed just below its level on the parallel. A couple of brace cleats are screwed to the first batten. To attach the stairs to the platform, the head of the former is lifted and the cleats on the batten across the stringers are slipped over the batten on the parallel. In this position, one batten rests on top of the other. The cleats prevent them from slipping apart. The parallel should be well anchored with stage braces to prevent it from tipping over.

If a long flight of steps is to be constructed, it is planned as a number of unit runs and parallels. When assembled, they are fastened together by 2″ loose-pin hinges or $\frac{3}{8}$″ carriage bolts (Ch. IV, Sect. 10). Balustrades, also, are made separately, attached to the edge of 1″ x 10″ planks and fastened to the flight of steps with similar hardware. When the side of a staircase is in view of the audience, the entire construction work may be

concealed by a triangular flat ("plug") fastened by loose-pin hinges to the face of the stair case.

A narrow stairway which does not have to reveal its steps from the side may be built without cut stringers. The treads are merely nailed to cleats screwed to the inside of the straight stringers. A small, portable unit, constructed on this plan, is illustrated in the drawing.

Steps should be covered with canvas before being painted (Ch. IV, Sect. 9).

15. A Column

A column (Fig. 40) is constructed by nailing wide sheets of ⅛″ profile around a light cylindrical frame. Wooden discs or rings, each made up of several pieces of 1″ x 6″ to 10″ stock fastened together with corrugated fasteners, form the core of the column. They are spaced at intervals equal to the width of the profile sheets and held in place by 1″ x 2″ strips running the length of the unit. The profile strips are wrapped around this core and nailed to the edge of the discs, or rings, as well as seamed along the strips. The column viewed from one side only needs but one good face. In fact; small columns are often made in half, that is, around half discs, called "half-rounds." This type of column, if it is not held erect by some other structure above, is secured by a brace cleat and stage brace fastened on the blind side. The column should be covered with canvas before it is painted (Ch. IV, Sect. 9).

Bases and capitals, the use of which is to be avoided if possible, on account of the nuisance of building them, must generally be made more solidly. Moulding may be made flexible for bending into a circle by making a series of cuts with a saw on the back or the front of the strip part way through at inter-

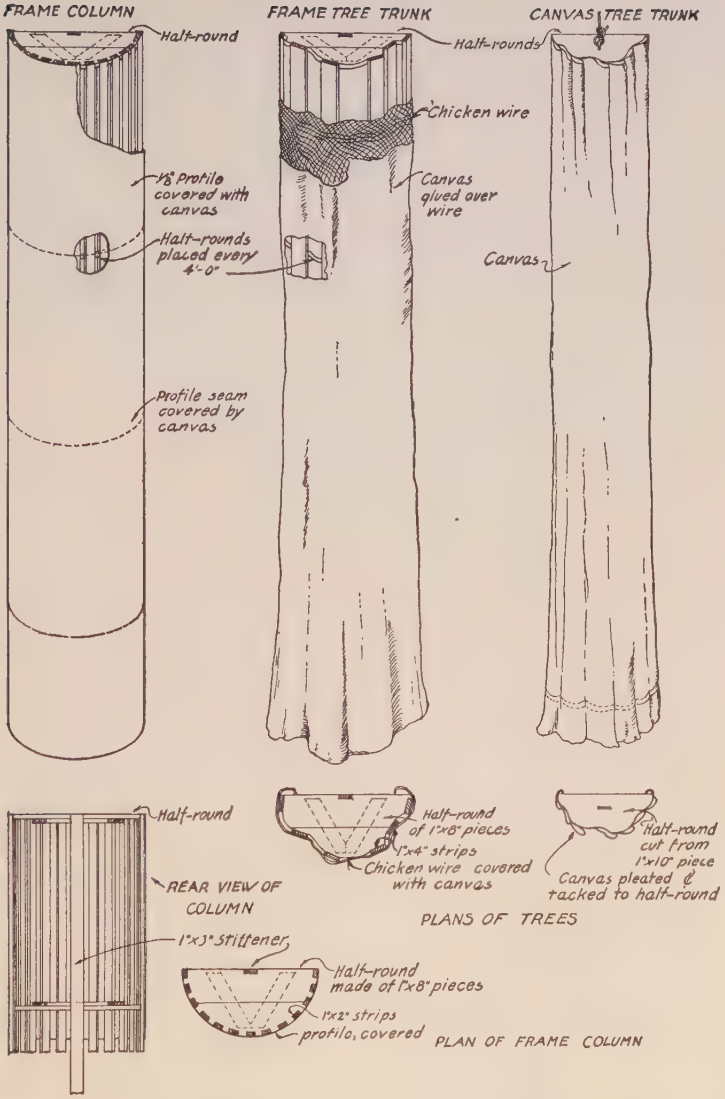


Fig. 40. A Frame Column, and a Frame and a Collapsible Tree Trunk
Scale, 1/4" = 1'–0".

vals of ¼″ to ½″ (Sect. 23). Ornaments may be moulded out of papier mache and, when dry, fastened in place with ordinary nails.

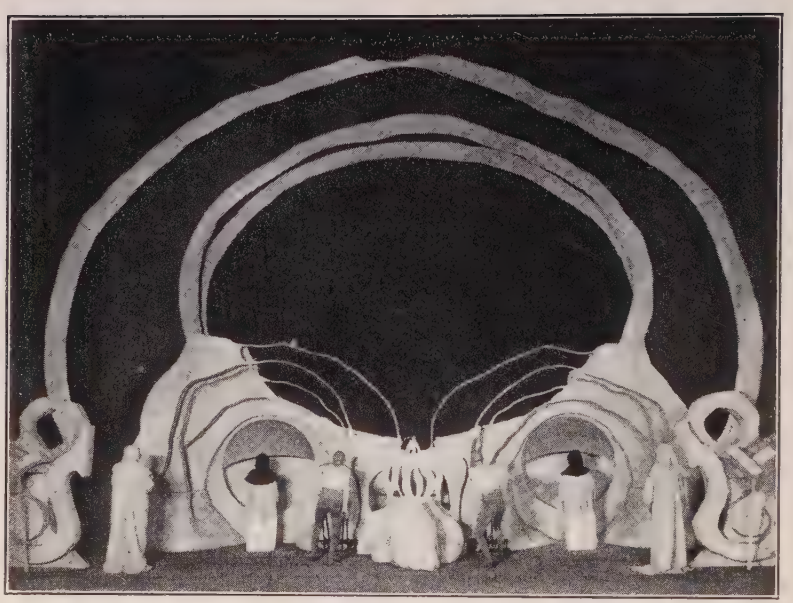
Columns are frequently constructed also in the form of simple canvas cylinders stretched between solid bases secured to the floor and wooden discs or frames attached to ropes in the flies. Cloth columns are practicable only, of course, in positions where actors are not likely to lean or brush against them.

16. Tree Trunks and Foliage

The construction of a "solid" tree trunk (Fig. 40) involves the same principles as those employed in the building of a column, except that a more irregular "core" is often used, and chicken wire and canvas are employed instead of profile. Irregularities, such as knots and excrescences, are built up on the half-cylindrical frame, and then chicken wire is tacked over the whole thing with ½″ staples. Small pieces of scrap canvas are dipped into the hot glue preparation described in Chapter IV, Section 9, and pasted, with their edges lapping, in irregular patterns over the wire. When this dries it gives a hard, uneven surface for painting a suggestion of bark. This type of trunk is held erect by using a brace cleat and a stage brace on the blind side.

If the tree trunk called for in the design occupies a position on the stage where the audience cannot scrutinize it too closely and where no actor will brush against it, it is possible to substitute a much more easily built collapsible form for the rather elaborate framed kind described above. A wide strip of canvas is tacked in irregular pleats around notched discs at the top and bottom and hung by means of a screw eye to a line in the flies.

Scenic environments for folk drama. A country store scene designed by Mary Holland and Samuel Selden for *A Shotgun Splicin'* by Mrs. Oscar J. Coffin; and a farm house setting designed by Samuel Selden for *Day's End* by Edith Daseking. Both plays were produced under the supervision of Prof. Frederick H. Koch by the Carolina Playmakers, University of North Carolina.



Two more examples of "style" in scenic design. Above: *Stylization* (the use of purposely exaggerated, or unnatural, shapes and colors) in a setting designed by Austin Strong for *A Play without a Name,* produced by Frank C. Reilly. Below: *Formalism* (the use of a simple, unrepresentative framework for acting) in a setting designed by Lee Simonson for *The Tidings Brought to Mary,* produced by the Theatre Guild.

The forest scenes in the original Provincetown Players' production of *Emperor Jones* were composed of such trees grouped on wires in front of cut-out drops (see Fig. 12).

Realistic foliage is very difficult to create on the stage, except in very expensive ways, and modern scenic artists consequently avoid its use as much as possible. Showing the lower portions of several realistic tree trunks in the foreground, they attempt merely to suggest masses of leaves and shrubbery in the background by using well shadowed cut-out drops kept discretely behind much scrim. Where foliage must be shown down stage, they use cut-out cloth borders hung in silhouette, as far as possible. The canvas is frequently gathered or draped, after it is cut, to add to the depth of the foliage (Fig. 35). The effects secured, especially in fairly dim scenes, is sometimes quite realistic.

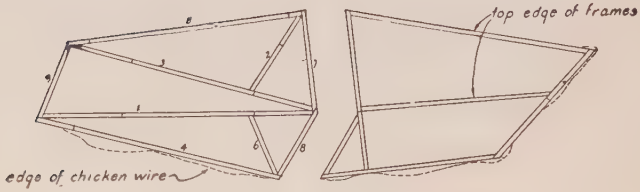
Conventional box hedges are occasionally constructed of green velvet attached to low frames covered with chicken wire, and spattered with large spots of glue, to stick down the nap here and there, and produce a mottled appearance. If the hedge is to be used for only a few performances, it is usually more practicable to cover the frames with real shrubbery than to use velvet, or any other imitation, which is seldom satisfactory.

Short lengths of vine and small bits of shrubbery can be made best out of artificial foliage materials bought in the five and ten cent store. At ten cents a sprig, however, their cost precludes their use for quantitative effects.

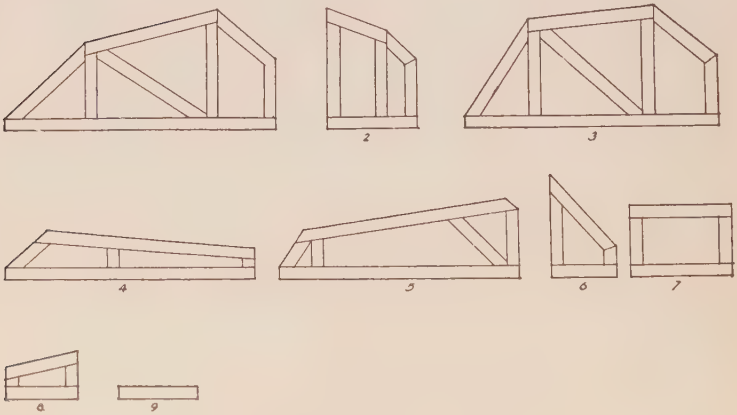
17. Rocks and Built Up Ground

Rocks and built up ground (Fig. 41) are made by covering light, irregular frames of 1″ x 3″ stock with chicken wire

ROCK



PLAN OF FRAMES · 2 SECTIONS



FRAME ELEVATIONS
OF LEFT SECTION OF ROCK

Fig. 41. A Frame Rock
In two Sections. Scale $\frac{1}{4}'' = 1'-0''$.

tacked down with ½″ staples, and covering the wire, in turn, with small pieces of canvas dipped in a mixture of hot glue and whiting, in much the same way that tree trunks are built. If the rock or ground is to be walked on, care must be taken to make the framework strong and rigid. The standard method for building a "practical" rock is to start with a number of vertical three or four sided frames, similar (except that these are irregular) to the sections of a parallel (Sect. 13). They are of different heights, some straight, some inclined, and some pointed. Placed edge to edge and edge to side, lengthwise and across, they are fastened together with 1¾″ No. 9 screws. In the parts of the rock that must be practical, additional battens are nailed at short intervals between sections, and these are covered with pieces of planking arranged in different planes. If the rock is large, it should be made in a number of smaller units pin-hinged, or bolted together. Tufts and folds of brown burlap or felt attached to the surface here and there may be made to suggest patches of earth and knots of grass.

18. Ground Rows and Silhouettes

Ground rows and other silhouette pieces (Fig. 42) are made by nailing 3/16″ profile over flat frames of 1″ x 3″ stock, which are put together with corrugated fasteners and re-enforced with corner blocks in the usual way (Ch. IV, Sect. 8). The silhou-

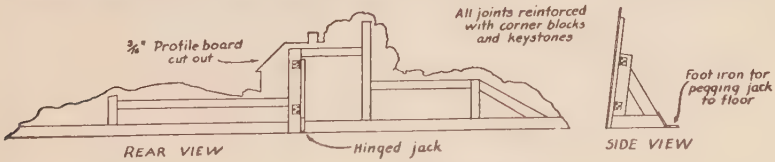

All joints reinforced with corner blocks and keystones
3/16" Profile board cut out
Foot iron for pegging jack to floor
REAR VIEW
Hinged jack
SIDE VIEW

Fig. 42. A Ground Row

Rear and side elevation. Scale ¼″ = 1′–0″.

ettes, are then painted and the outlines are finally cut out with a compass saw. The unit is made to stand up by hinging a triangular brace, called a "jack," to its back. Small units may use an angle iron in place of the jack.

In an emergency a rather convincing distant mountain can be suggested by pinning a piece of light blue or violet tarleton on to the bottom of the sky drop.

19. Walls and Fences

Walls and fences, made as independent units, whatever their design, must be fairly strong as well as light (Fig. 43). Heavy appearing parts should be made in skeleton form; that is, brick or stone parts, rails and posts should be shells only, put

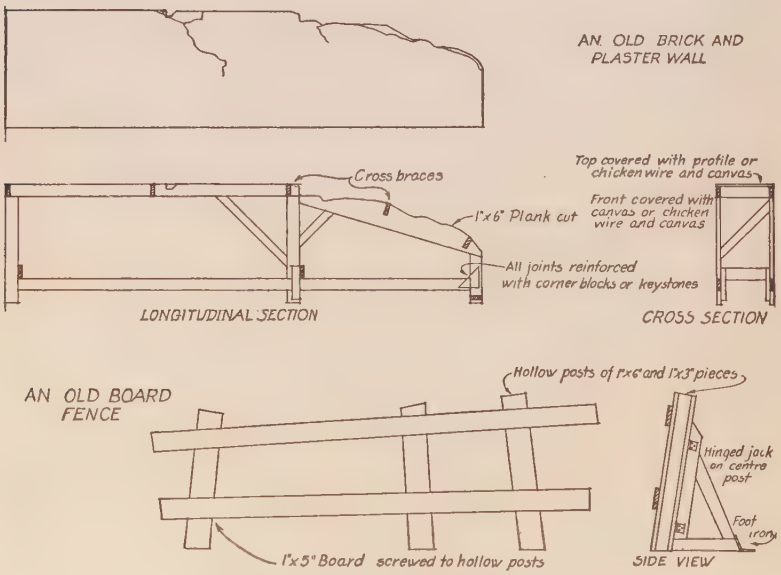

AN OLD BRICK AND PLASTER WALL
Cross braces
1"x6" Plank cut
Top covered with profile or chicken wire and canvas
Front covered with canvas or chicken wire and canvas
All joints reinforced with corner blocks or keystones
LONGITUDINAL SECTION
CROSS SECTION
AN OLD BOARD FENCE
Hollow posts of 1"x6" and 1"x3" pieces
Hinged jack on centre post
Foot iron
1"x5" Board screwed to hollow posts
SIDE VIEW

Fig. 43. A Set Wall and Fence

Scale, $\frac{1}{4}'' = 1'-0''$.

together with light lumber and covered (in the case of walls) with profile board, canvas or chicken wire and canvas. Fence sections are made to stand up by means of jacks (Sect. 18).

20. Log Cabin Walls

A simple method of suggesting the solid log walls of a cabin is outlined in Section 18 of the following chapter.

21. A Beam

A large beam, or log, seen in three dimensions in a stage setting, is constructed as a light shell of wood, or wood and canvas. If it is small, it is built out of ½″ planks put together in the form of a long, three-sided trough. If it is large, each of its faces may be made as a narrow batten frame covered with canvas. If it is irregular in shape, it may be modeled by the use of chicken wire and rags dipped in glue (Sect. 16). The beam is fastened in its position in the set by means of ⅜″ carriage bolts and wing nuts or picture frame hangers and sockets (Ch. IV, Sect. 10).

Square posts and pilasters are made in the same hollow form.

22. Irregular Three Dimensional Combinations

The construction of irregular three dimensional units, such as dormer windows, alcoves, and perspective set houses—which have to be planned for two dimensional striking and storage—is always something of a problem. A unit of this type, considered as a combination (often quite complicated) of a number of flat, or semi-flat parts, must be analyzed by the designer and carpenter down into its simpler elements. Each part is laid out and built as an independent unit. The various members are then

assembled by means of tight-pin hinges, loose-pin hinges, and ⅜″ carriage bolts and wing nuts (Ch. IV, Sect. 10) in the least involved method possible under the circumstances.

Figure 44, by way of illustration, suggests how a small, irregular set house might be laid out. The front and end walls are constructed separately, covered with canvas and then fastened together with tight-pin hinges in such a way that the three frames may be folded up backward like a double return (Sect. 4). The rear wall is constructed and covered, and fitted with loose-pin hinges to enable it to be fastened to the end walls (on the inside) when the little house is set up in the wings before the performance. A ridge pole cut to brace the top of the house is fastened to the two end frames by means of picture frame hangers and sockets (Ch. IV, Sect. 10) or shutter bolts. The roof (only the front half in this case is necessary because the back cannot be seen) is made in the form of a separate lid with a stop batten all the way around on the inside to prevent its slipping up, down or to the side.

If the roof is carefully made and fastened in place with loose-pin hinges when the house is set up, no additional bracing is necessary.

The chimney, a light box frame covered with light profile board or canvas, may be pin-hinged or bolted to the ridge pole. The door and window in a house of this small size can, if they are not to be "practical," be simply built up on the surface of the walls in which they are supposed to hang. If the roof is supposed to be shingled it is quite sufficient to use two rows of real wood and to suggest the other rows with paint.

The house just described would be a small one. If a larger "practical" house were required, the walls could be constructed in the same way, but they would have to be either lashed or

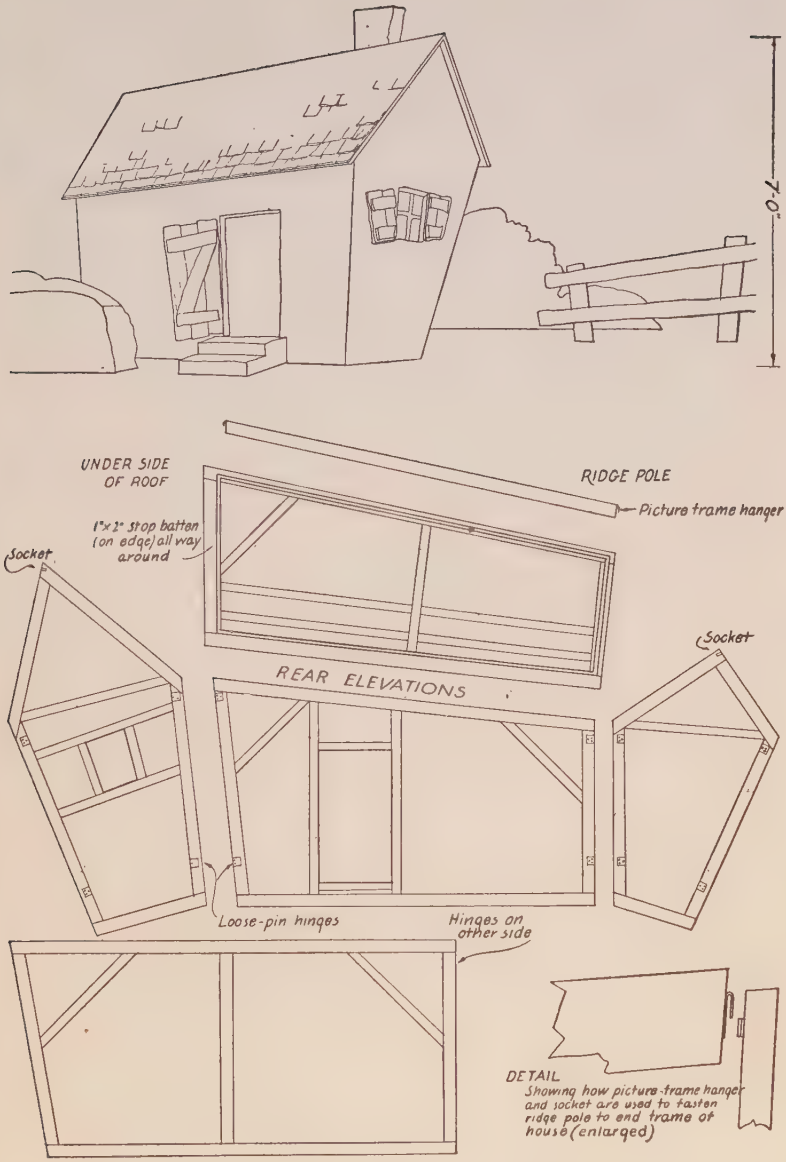


FIG. 44. A SMALL SET HOUSE

A set piece of this type may be combined very effectively with set walls, fences and ground rows in the background of certain exterior scenes.

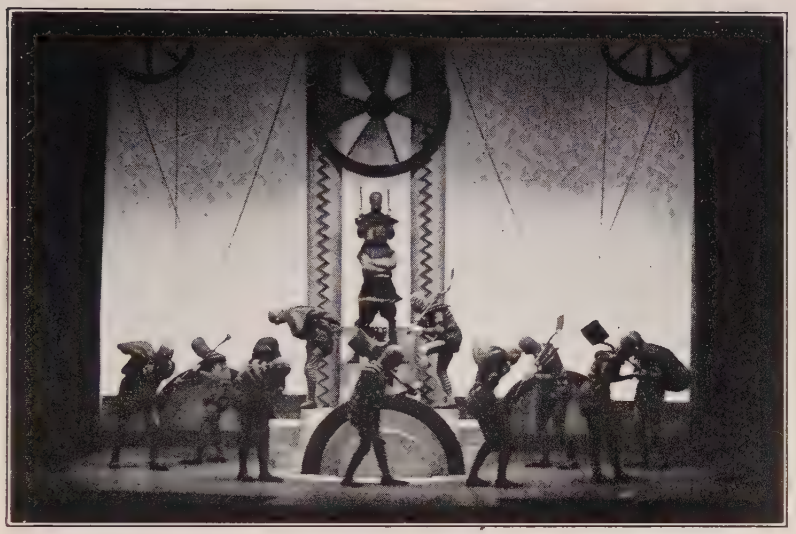
bolted together, and additional bracing would be required to keep them in position. The roof could still be fastened with loose-pin hinges. Door and window frames would be made separately and fixed in position in the usual way (Sects. 6–7). If it were desirable to bring the house onto the stage in one piece for rapid shifting it could be flied by means of two piano wires painted black, to make them invisible, attached, an end of each, to the end frames, and the other ends to fly ropes. Or the house might be mounted on a "wagon"—that is, be bolted or pin-hinged around the outside edge of a wagon built to its shape—with about ½″ clearance from the floor (Ch. VII, Sect. 11) and rolled in from the side.

This description of a knock-down house will suggest some methods of approaching the problems of other irregular three-dimensional pieces of scenery.

23. The Use of Moulding

Decorative woodwork in a setting, such as that around doors, windows, fireplaces and pilasters, as well as bookcases, cupboards and other standing properties constructed as scenery, should be dressed with moulding. The woodwork never looks quite convincing without it. Moulding may be ordered in a wide variety of designs. The most generally useful for elementary construction on the stage is 1″ panel moulding. This is adaptable to many purposes. It can be built up, when desired, by having a lattice strip placed beneath it.

A length of moulding can be curved to follow an arched line by making a series of cuts with a saw part way through, about an inch apart, on the edge to be made concave. To fasten the



Two scenes from plays produced on non-professional stages. Above: a dramatic setting used by the Festival Theatre (Cambridge, England) for the Ant Scene in its production of Capek's *The Insect Comedy.* Below: a setting by Janis Muncis for Vsevold Ivanov's *The Armored Train,* produced recently by the Pasadena Community Playhouse.

Two more interesting scenes from the non-professional stage. Above: Alexander Wyckoff's design for an outdoor production of *Twelfth Night* at Walter Hartwig's Manhattan Theatre Camp, Peterborough, N. H. The entire play took place in this one setting, which represents a portion of the City of Illyria "on the sea-coast of Bohemia." On the left is Olivia's palace, on the lower levels of which the revelry scenes were played. On the right is the palace of Duke Orsino. In the center upstage, are various gateways to the city, while down stage, below Orsino's Palace, is the sea wall. Below: a setting for *He Who Gets Slapped* revived under the direction of William Dean by the Palmetto Players of the University of South Carolina.

bent moulding in place use 1″ lath or finishing nails. Place them about 3″ apart and drive them, not into the strip itself, but into the saw cuts. This will prevent splitting the little segments of wood.

CHAPTER VI

THE PAINTING OF SCENERY

1. Introduction

There is little work associated with the technical department of play production more fascinating than that of scene painting. To the unitiated it often appears to be a rather mysterious and wonderful art; the ability to daub and splash color wash on flat canvas with an eight-inch brush and make the result look from a distance like a rough plaster wall, or sky, or mist-covered mountains seems little short of a magical one. It is assumed by many people that the processes of securing such extraordinary effects must be difficult and complicated. As a matter of fact, they are usually quite the contrary. To become a completely accomplished artist of the stage demands, of course, many years of study; but to learn to conceive and paint simple, attractive settings for the more common types of modern plays is no very difficult achievement. For this work, some understanding of drawing and composition, and a good eye for color, are essential. Anyone, however, who has done a little free hand sketching and painting in water colors should pick up the tricks of handling the larger medium of scene paints fairly easily.

2. The "Tricks" of Scene Painting

The first "trick" the artist learns is, obviously, to exaggerate. All painting for the stage must be done in a bold and free

manner. Impressions are made at a distance. Fussy details of design and color do not carry, and are consequently lost upon an audience. The smallest brush in common use in scenic work is two inches wide, and the ones more often employed measure from six to ten. It requires some courage to use these at the start, and a considerable amount of experimenting must usually follow before they feel altogether friendly to the hand. But in time they become as easy to manage as little brushes.

Another "trick" that must be learned is to paint for stage lighting. The latter has a tendency to change not only the quality of color, but its intensity as well. Consider its effect upon make-up. "To appear to be natural from the audience one must be unnatural on the stage," was most forcefully proved for the writer when he saw Mr. Cleon Throckmorton, at that time Art Director for the Provincetown Playhouse in New York, apply brilliant touches of green, red and blue to the leaves of a real rose vine in a garden set to make the plant look from the audience like something more healthy and impressive than the pale weed it appeared to be before.

Scene painting can really be learned only through experience. The artist who is working in the medium of scene paints for the first time should not be discouraged if at the start he finds he has to do considerable experimenting to arrive at the effects he wishes to secure. Fortunately, scene paints are opaque and cheap and one coat may be washed on top of another as long as the glue will hold to the canvas.

3. Paint Materials

The following materials are required for painting:

Scene Paints. Distemper, or water color, is employed almost

exclusively on the stage, its advantages over oil being: that it is applied more easily and quickly, it dries more rapidly, it does not shine, it is cleaner to handle, it is far cheaper and it is not inflammable. That which is known as *Scene Paint* is the pure pigment in powdered form. Before it is used it must be mixed with glue and water. It is sold in fifty or more colors. Some of the most serviceable ones, which may be ordered from one of the firms listed at the end of the book, if they cannot be got locally, are given below with their approximate price per pound:

Italian Blue	$.70
Ultramarine Blue	.35
Venetian Red	.12
Raw Sienna	.12
Burnt Umber	.12
Yellow Ochre	.15
Light Chrome Yellow	.30
Medium Chrome Green	.25
Hanover Green	.60
Drop Black	.25

Other useful colors, some of which cost a little more, are: Lemon Yellow, Burnt Sienna, Vermillion, Permanent Red, Purple Lake, Orange Mineral, and Emerald Green.

The use of ready-made calcimine preparations is not to be recommended except when it is impossible to secure the pure pigments. They are usually too pale for the purpose of painting scenery and most of them come in a limited variety of colors, and in addition they are mixed with a binding agent not very suitable for canvas surfaces.

Whiting. By far the most useful pigment for the artist is ordinary bolted whiting. He should estimate that he will use as much of this pigment as all the rest put together. Whiting

may be bought at nearly every paint and hardware store, at a cost of from three to four cents a pound, and may be mixed like any of the other powders. Only good grade whiting should be used. Belgian whiting is a standard.

Glue. Flake glue is preferable to ground glue, though either may be used. These must be cooked. LePages, which needs no preparation, may be employed in an emergency—only in an emergency, however, because not only is it too expensive for general use, but also it has a bad tendency to gray out any pigment mixed with it. Nearly all other cold water glues are to be avoided entirely.

4. Painting Implements

For painting scenery four different brushes will be found serviceable: one 8-inch and one 6-inch "sizing brush," for covering large surfaces rapidly, such as in priming; one 4-inch "laying-in" brush, for smaller areas; and one 2-inch "lining brush" for detail. There are a number of other types, such as round "foliage brushes" and special "liners," which might be mentioned; but the four above will be found to be adequate for most purposes. They should all be of the good quality long bristle variety used in distempering walls. Brushes deteriorate very rapidly unless they are taken care of. After every painting they should be rinsed, shaken out, and laid back to dry in a flat position. Never place a brush in boiling water.

Other necessary implements for the artist are:

A yardstick
Charcoal sticks
A snap line (about 40 ft. of heavy braided cotton cord)
A straight-edge bevel liner, for ruling short lines

A 12 ft. batten with a perfectly straight edge, for ruling longer lines
A number of 2-3 gal. pails and smaller pans
A gas, electric, or kerosene stove with two or more burners

5. The Paint Frame

Another aid to the artist, found in the best equipped studios, is the "paint frame." It is a large rectangular wooden skeleton, suspended from a set of ropes or cables, and big enough to accommodate a whole drop or set of flats spread out and fastened to it.[1] Slots are cut in one or more floors to permit its being raised and lowered through them, and to allow two groups of artists, if necessary, to work on a large piece of scenery at the same time. The frame is counterweighted and operated by means of a winch or some other manual device. Any type of flat scenery can be painted on this contrivance. This method of painting offers several advantages over the flat-on-the-floor method; it saves the artist's back by allowing him to do his work in an upright position; it spares his having to tramp over the surface of the canvas; and it gives him the opportunity to step back occasionally and view the progress of his labor. This is all important, however, only if scenery must be done in quantity. A Little Theatre should not worry itself over the problem of investing money in an expensive paint frame unless it has plenty of room in its workshop or on the stage, and unless more important equipment has already been paid for. Flats and drops can be painted very well on a large floor. Many of the busiest professional studios throughout the country use this method entirely.

[1] Paint frames are sometimes rigged on stages. See Figure 57.

6. The Elements of Color

A better understanding of the use of paint will be gained by those not already familiar with the principles if a moment is taken to discuss the first elements of color. The three "primary" (foundation) pigment colors—as they are fixed in most color

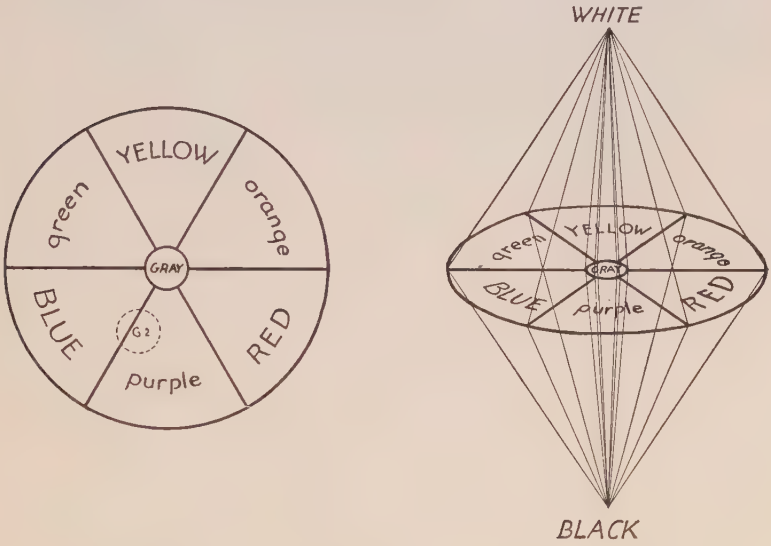


Fig. 45. The Color Wheel and Color Solid

G 2 in the color wheel indicates the true position of gray in relationship to the other hues (for color mixing).

theories [2]—are red, yellow and blue. The three "secondary" pigment colors are orange, green and purple (sometimes called violet.) [3] When the former are combined, they produce the lat-

[2] There are so many so called "color theories," each supported by excellent arguments, that is is impossible to pretend that the one outlined here is the one and only true theory. The artist will find it, however, quite representative and thoroughly practicable.

[3] Red, yellow and blue are approximated on the scene painter's palette by Permanent Red, Light Chrome Yellow and Ultramarine Blue; and orange, green and purple by Orange Mineral, Light Chrome Green and Purple Lake.

ter. That is, red mixed with yellow produces orange. Yellow mixed with blue produces green. Blue mixed with red produces purple. We find it easy to understand the nature of these colors if we arrange them in a circle or "wheel," as illustrated in Figure 45. Colors neighboring each other on the wheel are called "analogous colors." Thus red, red-orange, and orange are analogous colors. Colors directly opposite each other on the wheel are called "complementaries." Thus, orange is the complementary to blue, red the complementary to green, red-orange the complementary to blue-green, and so on. In the center (or approximate center) of the wheel is gray,[4] the absolutely neutral point. Colors are brightest near the outside edge of the wheel and dullest near the center.

When two colors, represented by two points anywhere on the circumference of the wheel, are mixed, they produce a third color. If this were represented in a diagram the third color, or blend, would be placed somewhere on a straight line drawn between the two original colors. The position of the blend on this line would depend on whether there was more of one of the original colors than the other in its composition. It will be seen that a point on this line (anywhere short of the extremities) is nearer to the hub of the wheel (grayness) than one on the circumference. This explains the fact that a mixture is never as intense in tone as a pure pigment. When two colors are combined

[4] For convenience in stating a theory the position of gray may be said to be in the direct center of the color wheel. In a practical discussion of the actual mixing of pigments, however, it must be assumed that the true position of gray is a little off center, toward the "cool" side of the wheel. This means that it takes somewhat more than an equal amount of blue, green or purple to neutralize (see following paragraph) orange, red or yellow. The correct proportion for mixing an absolute gray out of the three primaries is supposed to be yellow 3 parts, red 5 parts, blue 8 parts—depending to some extent on the purity of the pigments and possible reactions between dye substances (Fig. 45).

they lose a certain part of their brilliance. If pure yellow is combined with pure red, for instance, an orange is produced which, because it is a mixture, is not quite so intense as a pure orange of the same hue. The more widely separated on the color wheel are the colors to be combined the grayer or more nearly "neutral," will be the blend. When complementaries (directly opposite colors) are mixed together in correct amounts they produce a pure gray. This is a useful principle to remember when preparing paint for scenery. A pigment which appears too bright may be very easily toned down, or softened, by the addition of a little of its complementary.

We have just glanced at the color wheel. This, however, is not a complete diagram of the behavior of color. If we place the wheel on edge, we find that it is merely a cross section of a three dimensional figure made of two cones with their bases placed together (Fig. 45). The points of the "solid" represent white and black and mark the extremities of the gray line passing down through the center of the figure. What happens to a color when it is mixed with white or black can now be seen very clearly. Not only is it lightened or darkened, as the case may be, but it is grayed as well. A cross section of the color solid may be taken at any point, between the extremities to produce a perfectly proportional color wheel. The only dissimilarity between one taken near an end and one taken near the center would lie in the fact that the colors on the circumference of the former (as they would all be mixed with more gray) would be less widely differentiated than those in the latter.

A color, then, has three characteristics, which are determined by its position in this figure. Its *Hue* is determined by its posi-

tion in relation to other colors on the circumference of the wheel—that is, by its redness, yellowness, or orangeness, or blue-green-ness, and so on. Its *Intensity* is determined by its nearness to the center—that is, the amount of gray, or of its complementary, it has in its composition. Its *Value* is determined by its lightness or darkness—in other words, the amount of white or black it has mixed with it. A light value of a color is called its *tint,* a dark value, its *shade.*

If we were to list some of the most obvious characteristics of color we would include the following:

Red, orange and yellow are "warm".
Green, blue, and violet are "cool".
Analagous colors are harmonious.
Complementaries offer the greatest contrast.
Light values of colors are more "exciting" than the darker values.
Darker values give a greater impression of dignity than the lighter values.
A little bright color outweighs much gray.
Mixing colors always lowers intensity. The more widely are separated the hues, the grayer will be the result.

The behavior of spectral (light) hues differs considerably from those of pigment (paint) hues. The color theory for lights is discussed fully in Part Two, Chapter VII.

7. Color Harmony

It is difficult to lay down any definite rules for the harmonizing of color in stage painting. Too much depends upon the texture of the materials involved, the composition of scenic elements, the lighting scheme and the distance from the spectator at which effects are to be produced for an artist to be able to

make many generalizations in advance. A few tendencies in color combination may, however, be noted.

Harmony is, to a large extent, the result of good proportion. Almost any color may be placed next to any other color, provided it is used in a relatively correct amount. Two colors, which clash when combined equally, will usually appear well together in unequal quantities. Proportion involves balance. A little intense color, for instance, as we have already noted in the preceding section, will weigh against a considerable amount of neutral color. The following "rules" for combining colors are founded on principles that operate under most conditions on the stage:

1. Various shades and tints of the same hue may be used together in any proportion.

2. Analagous hues (that is, those lying near each other in the color wheel) may be used together in any proportion, if they are used alone.

3. Complementaries may be used together in unequal proportion.

4. Strict neutrals, very light tints, or very dark shades may be used together in their own classes in almost any proportion.

5. Intense colors may be used with neutral in almost any proportion; though balance, especially in the consideration of large designs, generally demands that the neutral predominate.

6. A neutral background may be used to tie together smaller masses of bright colors that would otherwise clash.

The greatest encouragement that can be given harmony is to keep the larger areas of the scene fairly neutral, and to sharpen up the sense of interest by building up intensities in certain smaller points only.

8. The Preparation of Paint

Paint is prepared by being mixed with a solution of glue called "size water," made as follows: 4 pounds of flake (or ground) glue are placed in a 3 gal. pail of water, allowed to soak for at least an hour (better over night) and then cooked on a stove. The pail is placed within another, with a little water and a block of wood or a brick in the bottom of the latter, double boiler fashion, to prevent burning. When completely dissolved, the glue is further diluted to make size water. Four pounds of dry flakes will make from 4 to 6 pails of size water. The more concentrated preparation may be kept as "stock" to be diluted as it is needed. Because time must be taken to remelt it every time it is used, however, it is wise to make up several buckets of size water at a time to prevent delay in painting. If glue is to be kept on hand for any length of time, a couple of teaspoonfuls of carbolic acid may be put in it to keep it from decomposing.

The glue solution should be warm when the pigment is added. Pour the powder into it slowly, stirring it thoroughly to prevent lumping, until the mixture has the consistency of heavy cream. It is difficult to give any more nearly exact proportions for mixing scene paints as both glue and pigments vary. Veteran artists judge largely by the "feel" acquired through experience. If too much glue is used the paint when dry will draw and crack on the surface of the canvas; if too little, it will powder on the hand rubbed across it. If too much pigment is used, the paint will seem stiff and heavy in brushing, and one stroke will have a tendency to pile up on top of the preceding one. If the mixture is too thin it will look transparent on the canvas.

The paint, when applied, should be at least slightly warm. The mixture in the bucket should be stirred from time to time to prevent the powder from precipitating to the bottom. If the pail is set aside for a while and grows cold, it should be thoroughly stirred and placed on the stove for a moment before being used again, care being taken that the glue does not burn.

9. Some Suggestions for Mixing Paints

It is seldom necessary to use colors pure, except for accents. For most purposes they should be mixed with at least an equal portion of whiting in painting the brighter blocks of color, and several times this amount in laying in the lighter tones. On the other hand, the use of whiting should be avoided when it is not needed. Whiting exerts a strong influence over other pigments in a mixture; even a small amount dropped by mistake into a pail-full of some dark paint (such as Burnt umber or Black) is apt to destroy its brilliance and make it appear chalky.

The various pigments may be mixed together in any proportion. In very unusual circumstances is an artist fortunate enough to be able to find just the tone of a color he wants without blending two or more together.

A word of caution should be given to those experimenting with scene paints for the first time. Water colors invariably look darker when wet than dry, mixtures containing white being especially tricky deceivers in this respect.

It is difficult to match blends. Before painting a sky drop or the walls of a set, therefore, it is wise to mix enough paint to insure its not running short at some critical point. Two 2 or 3 gal. pails full will take care of a drop 25′ x 30′, or a set of seven flats of standard width and 12′ high, very nicely.

10. The "Prime Coat"

The first coat of paint is called the "prime coat." Its purpose is to close the pores of the canvas and prepare a working surface for the following painting. Because whiting is the cheapest powder, it is commonly the chief ingredient used, but any other pigment may be employed equally well. Left over scraps from the previous day's painting may be "boxed" together (poured back and forth into each other) and warmed up to prime the new flats. The tendency in the professional studios is to prime a set of scenery with the tint of a color approximating the final tone of the scenery if the effect is to be "smooth" and with a complementary to this tone if the effect is to be "rough." To prepare a foundation for an open texture the priming is often done with several different colors. The only fixed directions for applying this first coat are: to use a large brush, and to spread the paint evenly, smoothly, and not too thickly over the canvas.

11. The Following Coats

One coat of paint should be allowed to dry thoroughly before applying another, otherwise the damp pigments will mix and produce muddy spots. If the paints are properly mixed, one coat will completely hide the preceding one (unless it is extremely contrasting or it is mixed with an aniline dye—see Sect. 28). If it does not, it is probably too thin. If one coat picks up another, the fault lies in one of three possibilities; the fresh paint is too warm, that beneath it is still damp, or the under paint lacks glue. A little experience will quickly teach one how to avoid bringing about such annoying conditions.

A Sketch for a Porch Scene

A setting designed by the author for *On Dixon's Porch,* by Wilbur Stout and Ellen Lay, as produced by the Carolina Playmakers.

12. Painting Over Old Surfaces

Painting over an old surface often presents some difficulty. Scenic glue deteriorates in time and loses much of its binding quality. The paint on old scenery is often so powdery that it is caught up in the brush strokes and mixed with the new coat—disastrously if the colors are dissimilar. The surface may be hardened somewhat by first sprinkling it freely with a strong solution of alum.

13. Surface Textures

Irregular surfaces on the stage are, when viewed from a distance, more interesting to look at than perfectly smooth ones. For some reason flatly painted scenery is never quite convincing; its chalky flatness reveals it to be what it really is, color-washed canvas. Even a slightly varied texture, scarcely recog-

nizable as such from the audience, seems to "carry" where the other will not. The theory of "broken color," which maintains that "scintillation" is secured by breaking up a desired tone into its simpler elements and placing these side by side in little blocks for the eye at a distance to blend into one, finds one of its surest proofs on the stage. A plainly tinted wall painted by spattering, one over the other, three coats, one red-gray, one blue-gray, and one yellow-gray, has a suggestion of life which one painted with the same colors mixed together in a pail and applied flat most clearly has not.

14. Some Methods of Applying Paint

The following are the most common methods of applying paint to scenery:

Flat Painting. The paint is brushed on smoothly and evenly. This is obviously the most simple method; useful for priming and laying on ground (base) colors.

Scrumbling. A fairly dry brush is passed lightly and with long free strokes over the surface of the canvas in various directions in such a way as only to conceal partly the surface beneath. Unless an effect of obvious blotchiness or streakiness is desired care should be taken to lay the strokes on fairly evenly. This method is useful for producing rough surface effects.

Sponging. A large sponge, trimmed to present a flat surface, is dipped into a pail of paint, squeezed out, and patted gently over the canvas. Care should be exercised in using this method also to cover evenly and avoid undue spottiness. The textural pattern should be continuous. It will be found helpful to pat in spirals or semi-circles and to turn the sponge constantly in the hand. Sponging also is useful for producing rough or patterned surfaces.

Rolling. An effect somewhat similar to that obtained by sponging can be secured by dipping and wringing out a ragged piece of coarse linen or burlap and either patting it or rolling it over the surface to be covered. This is an excellent method to use for imitating old plaster or rock surfaces.

Spattering. A brush full of paint is shaken over the canvas or snapped by the wrist so that the paint falls in little drops. To

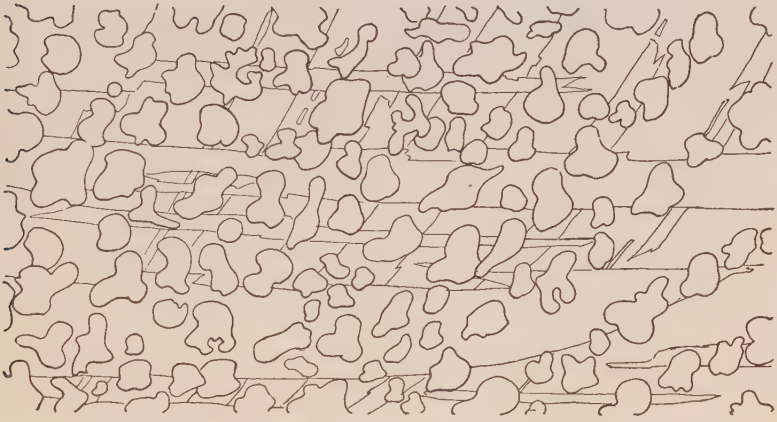


FIG. 46. SPATTERING

Full size of effective spattering for a "smooth" texture. For a "rough" texture the spots should be three or four times this size. Applied over scrumbling.

insure evenness, it is well to start with one end or corner of a piece, or group of pieces, of scenery and proceed systematically to the opposite one. Be generous with the paint. A few tiny speckles will not be effective. At the same time avoid dribbling from an over wet brush and dropping large spots which the audience will recognize as paint, thus destroying the illusion of texture. If it is difficult for the artist at the start to spatter evenly, he will find it helpful to snap the brush by striking the

wrist of the brush hand against the wrist of the other hand on each shake of the brush. One secret of good spattering lies in loading the brush each time with the same amount of color, that is, in dipping the bristles into the liquid the same distance (never more than about three quarters of the way). Spattering is the method used most for producing broken color impressions. It is often combined with one or more of the other methods (see Figure 46).

If a series of flats in a wall, or any other group of pieces which must be set together in a scene, is to be painted by one of these methods, it is imperative that they be laid side by side in the proper order on the floor as a unit to insure their being matched.

There are few really standard ways of painting scenery. The successful artist is an inventer and experimenter. The suggested solutions of the various problems that follow should be appreciated as hints chiefly for beginners. These hints will be modified or disregarded as one discovers better methods.

15. Interior and Exterior Walls

The principles of broken color (Sect. 13) may be used in developing wall surfaces which are intended to appear either smooth or rough. For the smooth surface, which suits interiors better than it does exteriors, choose two or three colors which are nearly alike, such as: blue-gray and yellow-gray; or light-cream, darker cream, and pink. Lay one of the colors on solid as a ground coat; when it is dry, spatter the second evenly over the first until it nearly conceals it; then spatter over these two the third in the same manner. If the spattering has been properly done, it should present a surface which, from a distance, at first sight will seem to be perfectly smooth, but upon closer ex-

amination will be seen to have just enough texture to prevent it from looking monotonous and uninteresting. If a hard texture is desired, the spattering should be done on a perfectly dry surface, if a soft texture, on a wet surface. Avoid working over a partly wet and a partly dry surface, however, otherwise the result will be very uneven.

The use of more widely separated colors in spattering will suggest stucco. If two or more colors are cleverly enough applied by the cloth-rolling method, a very convincing effect of old mottled wall paper may be produced. If a more pronounced design is desired, simple figures may be cut in oil paper and stenciled onto the wall. In applying the paint use an almost dry brush to keep the paint from running. Avoid any very conspicuous patterns or they will probably refuse to lie at rest on the surface. If the figures appear too vigorous when viewed from a distance, spatter them over lightly with a little of the ground color, to tone them back into the rest of the wall. Remember at all times that good scenery acts as an environment and does not intrude itself into the play.

Sponging, another popular method employed in treating interiors, may be combined with either or both spattering and rolling. If carefully handled, quite dissimilar colors may be used together to produce interesting blends.

Old stained plaster, particularly effective for exterior walls, may be suggested by scrumbling and blocking-in large irregular patches of various light and dark browns, or yellows, reds, and blues, and spattering this all over, while still wet, with the same colors. Keep the darker tones at the top. As dark blue under the prevailing straw and amber lights of the stage looks nearly black, a little of this color may be mixed with a small amount of real black and sprinkled *very lightly* here and there over the

plaster, to suggest holes and crevices. Guard against large drops or you will give away your secret.

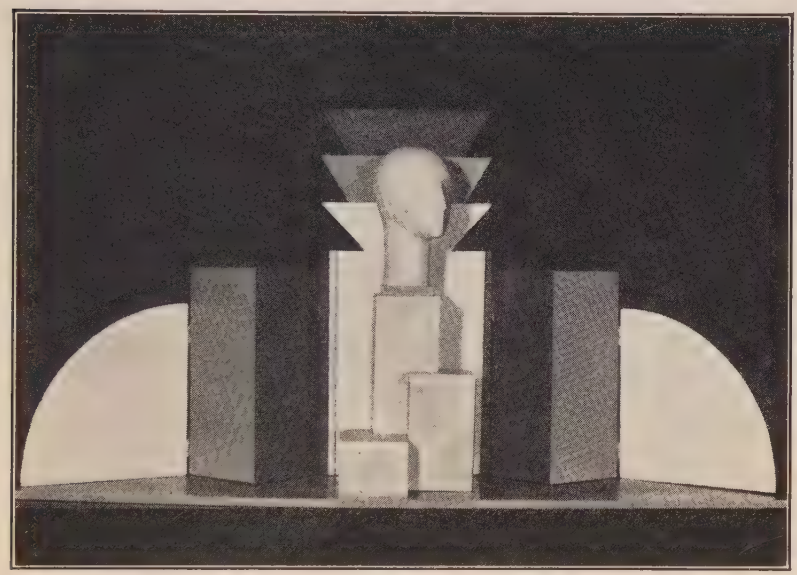
In order to give interest to high lights and shadows, and to produce other interesting qualities, through light reflection, in various kinds of textured wall surfaces, use is frequently made of aluminum (silver) powder (see Sect. 25), which is either mixed directly into the body paints before they are applied, or is made up with size water into a thin wash and spattered over the body coats (Sect. 16).

Brick walls should be handled thoughtfully. Rows of regular red rectangles with hard white lines between, seen so often on amateur stages, never look very real. Even the most evenly laid walls in actual life show many irregularities and signs of weathering. One good plan to follow in painting is to scrumble in first the plaster effect (later to be seen between the bricks) in a full ground coat—not in one tone, but in two, or three slightly different ones—and then to lay the bricks in lightly on top of this with a comparatively dry 2 in. or 3 in. brush. Vary red with a little neutralized orange, brown, and blue. It is well to keep the bricks in fairly straight lines, of course, but do not attempt to paint them too regularly. Knock off a corner here and there and touch occasional edges with darker blue to suggest stains. After the bricks have been laid in spatter them all over very lightly with the same colors. Keep in mind that an *impression* is what one is trying to create, and that fussy details are lost on the audience.

The usual caution may be repeated: Avoid extremes. In developing interiors or exteriors guard against painting walls either too bright or too dull. They would be equally conspicuous in both cases.

16. The Shading and "Toning" of Walls

In creating wall surfaces an artist must work constantly for variety. He should give special attention to large plain areas. Unless they are well painted they are apt to appear bare even



Scenic Design Applied to Modern Display Advertising
A background for a display window designed by J. Albert Bliss.

under the best lighting. It is not enough simply to suggest texture (see Sections 13–15). The artist should work for some difference between illuminated and shadowed areas. The light concentration on a high wall in a night scene, for instance, would naturally be near the bottom where the actors stand and walk in lamplight. In treating such a wall the artist might wisely

lay his lightest tints here, and then shade them off gradually into deeper and deeper ones as he proceeds toward the top, until the wall appears to melt, of its own accord, into darkness. The outer edges of the wall, away from the light source, might likewise be made to step off into the shadows.

Wall surfaces may often be given increased interest by "toning" (tinting or graying) them with a light scrumble or spatter of aniline dye disolved in size water (Sect. 28). One or more tints or shades may be used. A thin wash of silver (Sect. 15 and 25) may be used in the same way. Dull looking walls may be given a remarkable sparkle without appreciably changing their color, by treating them like this with silver. The dye and silver powders may be mixed in the same bucket, if so desired, and thrown together.

Both shading and toning, if they are to be at all effective, must be done very subtly.

17. The Imitating of Woodwork

Woodwork is very difficult to imitate satisfactorily with canvas and paint. As far as he can reasonably do it, a professional scenic artist likes to use real lumber on the stage. This he can do without great difficulty where it involves door frames and mouldings; but it is obviously impossible to build a complete wooden interior to represent a shack or a log cabin. Where rough boards must be represented by painting, lay a ground coat of gray-brown, rule the flats with charcoal to indicate positions of the planks, and scrumble in each with a couple of shades of brown, blue, and gray, using long strokes and avoiding making one plank exactly like the next. Alternate a couple of darker ones with one a little lighter and vice versa. Vary the ends, or

the middles, of boards. Stain the edges of occasional boards. Now take a little Yellow Ochre, mixed with white, on an almost dry brush, spread the bristles of the latter, and with long sweeps suggest, very lightly, some more pronounced graining here and there. If the pattern of the graining must be made more obvious, mix up a little black analine dye (see Section 28) and sweep it on in the same way with an almost dry brush. If the brown and yellow show up too brightly, reduce their intensity with a little gray or blue. Finally, outline the boards lightly and free-hand with blue mixed with black, and spatter a few fine drops of the same paint over the entire surface to help suggest the rough texture of the wood. A little real lumber seen in beams and supports will help to create the illusion. The convincing board effect in the walls of the mountain post office setting opposite page 130 was secured by tacking pieces of 1½″ lattice to the faces of the flats to suggest weather strips, and then painting the "boards," as well as the real strips, in the manner described above.

18. Log Cabin Walls

To suggest the walls of a log cabin model the surface of the flats before painting by means of long strips of waste cloth—such as scrap canvas, flour sacks and any other rags—dipped into a mixture of hot glue and whiting (Ch. IV, Sect. 9) and pasted on to suggest the roughly chopped edges of logs, with clay showing between. The raised portions should be 5″ to 7″ wide, and the spaces between 2″ to 3″ wide. Apply the rags hot, glue them firmly to the canvas, and wrinkle them to suggest the crude longitudinal grain of the wood. As the strips contract considerably in drying, avoid pulling them tightly when putting them on the flats.

Each log should run the full width of a wall. The flats composing a wall must therefore be laid together on the floor and done as a unit, that is, with the strips of cloth carried over the cracks. The flats may be cut apart afterwards. Corners, where two walls meet, must be carefully matched. As the log ends must seem to dovetail, the strips where the two walls join must be arranged in a stagger pattern. If the set is an exterior, the round ends of the wood at each corner should be shown.

When dry, scrumble the log strips in long irregular streaks and blocks of dark and light grays, browns, and blues; then darken the edges, and put bits of shadow in with dark blue and purple under and above each strip to accentuate the "thickness." Suggest clay in the cracks between by blotches of light yellow, blue and gray. Paint boldly and freely and work for variety and contrast between the wood and the mud.

19. The Sky

A large drop, high enough and wide enough completely to back up all exterior views, and painted pale blue, is commonly used to represent the sky (Ch. II, Sect. 11). As it depends chiefly upon lighting for its effect, its own tinting should be very soft. Mix not more than 3 or 4 oz. of Italian Blue in a full pail of white, and apply the paint with a large absolutely clean brush, taking great care not to streak it. If it is a big drop, prepare two or three buckets of paint and "box" them thoroughly (that is, pour them back and forth into each other) before starting. To run short and attempt to match tints in the center of the sky is disastrous. The sky may be given a little texture and a surface which will better reflect different qualities of light which may be thrown on it if it is spattered very carefully and evenly with

pale, closely related tints of pink, purple and blue (one value darker than the main blue), with also, perhaps, some white. It may be given added "scintillation" by mixing into the paint a little aluminum (silver) powder (Sect. 25).

The old-fashioned practice of painting a landscape on the sky drop is now frowned upon by the best artists. Besides being difficult to do, it never produces very convincing results, and it limits the use of the drop. A simple sky may be used in every set of a play, while a painted landscape fits the locality of only one scene.

If a cyclorama is used to represent the sky (Ch. II, Sect. 11) it is painted in solid or broken tints of very pale blue, and sometimes other colors, like the drop.

A "dome" (see same section) may be painted in the same way.

20. The Landscape Pieces

The character of an outdoor setting is better suggested by a few plastic "set" and "built" pieces, such as ground rows, silhouette hills, rocks, trees, and fences placed in front of the sky than by anything placed on the drop. The construction of these is described in the previous chapter (Ch. V. Sects. 16–19). In painting them it is well to keep in mind that, except possibly for the sky on a cloudless day, there are no large masses of flat color in nature. Even a simple tree trunk will show a surprising number of colors—perhaps a dozen or more browns, grays, blues and greens. Of course it would be impracticable to indicate very many of these, but at least two or three tones should be used to indicate that a piece of scenery represents a tree trunk, not a painted post.

Rocks are never a dead gray. For painting the lighted side

of a block of granite use warmer colors, perhaps a dull cream varied with a little rose pink, light brown and pale blue; while in the shadows use cooler colors, blue, bluish-green and purple. Greenish patches of moss may be added. A sandstone wall would be painted in the same way with the addition of a little yellow. Work freely in large blocks of color. Sprinkle the whole piece lightly, when done, with a small amount of dark and light blue to break up the smooth surfaces and add texture.

Paint mountain rows in light greens, blues and purples, and spatter them well with pale violet (Ultramarine Blue with a little Venetian Red) to soften their outlines into the sky. Distant banks of earth may be suggested in much the same way by using Burnt Umber, Ultramarine and Italian Blue. Wherever possible run a little of the sky color into the far away objects.

In planning landscapes, keep colors as light as possible; vary the values of tints; and avoid black shadows. Paint objects in the foreground in purer, brighter, colors than those in the background.

21. Foliage

To repeat the remark made in Chapter V, Section 16, thoroughly convincing foliage is very difficult to paint. The tendency now is to avoid the use of definite shrubbery, and other leafy pieces, as much as possible. In out of door scenes calling for the presence of trees, an artist generally tries to design his setting in such a way as to draw the main attention to three or four nude, but convincing, solid-looking trunks rising out of sight behind the teaser in the more brightly lighted foreground, while merely suggesting masses of leaves, intertwined branches, and silhouettes of other trees (done by means of dark cut-out drops kept discreetly behind much scrim) in the shadows of the back-

ground. If a foliage piece, such as a masking border, must be used in the foreground, paint it in blocks to hint at clumps of leaves, rather than individual ones; cut the edges and punch holes in the border (according to the characteristics of the foliage represented), and hang it in silhouette as much as possible. Dark Chrome Green, Leaf Green Lake, and Hanover Green are good foliage colors. They may be modified by mixing white into them. A few touches of neutralized red here and there will add roundness to the blocks of green. Some artists prime their foliage pieces with pure Ultramarine and paint into it.

Vines and small bushes are best made out of materials secured at artificial flower shops, or five and ten cent stores. Their cost, however, precludes their use for quantitative effects.

For other foliage suggestions see Chapter V, Section 16.

22. Mist and Distance Effects

Mist effects are created principally by the use of "scrim," a dark blue theatrical gauze (Ch. IV, Sect. 5, and Ch. V, Sect. 16). One or more thicknesses of it, in the form of a drop, are hung in front of the whole, or part, of a scene. If lights are carefully kept off of it, the gauze itself remains invisible but the objects behind it are blurred as though seen through a haze. If two or three small streaks of light are thrown across it a suggestion of fog is produced. The whole scene back of the scrim may be blocked out by removing the light from behind and bringing it up in front. This is the way the famous "transformations" of the old theatre were effected. The atmospheric vapors natural to a landscape contribute much to the impression of distance. Scrim, therefore, is useful for this effect also. With the aid of the right kind of lighting, a deep woods scene can be suggested very

simply within a few feet of stage space by hanging, one behind the other, several foliage cut-out drops with pieces of scrim glued over the open spaces of each (Ch. V, Sect. 11). From the front one sees each succeeding silhouette more and more dimly, and consequently, gets the feeling that the last group of trees is quite far away.

Certain colors, also, give the impression of distance. Pale blues and violets are especially helpful in this respect. A little very light Ultramarine or Italian Blue spattered over a row of hills will make them appear to sit ten miles closer to the horizon.

23. Painted Shadows

A word should be said about shadows. They are never black. They may be brown, green, purple or almost any color except pure black, which is dead. The ideal plan, of course, is to arrange a set in such a way that shadows will be cast naturally without painting; but where they must be made synthetically the tendency is to use pigments that are neutralized complementaries to prevailing colors in the lighting. Where the illumination is amber or straw (yellow), the shadows are of blackish, or grayish, blue; where blue-green, of red; and so on. "Painted darkness," however, is at best a make-shift. To be effective at all it must be subtle. It should not appear to have been laid in with a brush. Heavy streaks and blotches are worthless.

24. Reproducing from Sketches

A design for a picture drop or other large piece of scenery must occasionally be copied and enlarged from a small working sketch. As it is difficult, at the close range from his canvas at which he must work, for an artist to keep the various elements

of an extensive composition accurately in proportion, he is compelled to make use of an analytical scheme of reproducing—in other words, to copy the design in small units. The following method is the one generally employed.

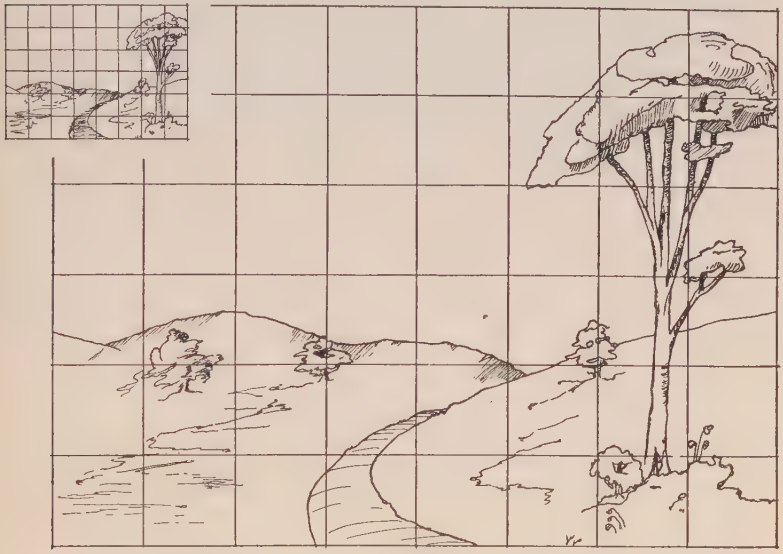


Fig. 47. The Method of Enlarging a Sketch

The sketch (Fig. 47), made to a definite scale, most commonly ½ in. to 1 ft. is ruled off with a pencil in 1-in. squares. The drop, primed with a working surface (Sect. 10), is likewise ruled off with charcoal in 2 ft. squares. These vertical and horizontal lines are done with either a long batten or a "snap-line." The latter is a heavy braided cotton cord drawn across a stick of charcoal, held against the canvas and pulled tightly at both ends. When it is lifted in the middle and allowed to snap back smartly onto the cloth, some of the charcoal, rubbed along the cord, is transferred to the canvas to make a dark streak.

The design is now transferred from paper to canvas, square by square, chalk or charcoal being used for the outline sketching. The drop is then painted. If any of the black or white lines still show when the painting is completed, they can be dusted out very easily with a dry rag.

It is sometimes advisable to work out a difficult detail or a repeat pattern at full size on a piece of wrapping paper first and then transfer this drawing to the canvas. After the drawing has been made on the paper the paper is perforated along the principal lines of the design with a small nail, or other pointed object, the paper is turned over and the burrs are sandpapered off the little holes, the pattern is placed in position on the drop and a small bag of lamp black is rubbed over the perforations.

25. Gold and Silver Metalic Paints

Bronze and aluminum powders, which are sold in a number of different tints and shades, are used to represent gold and silver in scene painting. They are mixed with a bronzing liquid for applying to wood and iron, and with a heavy glue size for painting on cloth. Size water in its ordinary strength (1 lb. glue to 3 gals. water—Sect. 8) is not strong enough, for the purpose; the proportion of glue should be doubled. To prepare the water color mixture, first make a thick paste of the metallic powder with a little of the heavy size water used hot, stirring it until it is thoroughly smooth; then mix in slowly more and more of the size water until the desired consistency is obtained. Place the mixture on the stove and bring it to a boil, stirring it constantly to make certain that it does not burn. Properly prepared this way, bronze and aluminum paints are thoroughly liquid when

warm, and quite stiff when cold. When they are being used they must be kept warm by being frequently reheated.

To make these naturally brittle paints a little more flexible for use on drops or other pieces which must be folded or rolled, add about a teaspoonful of glycerine to a pint of liquid.

If a metallic powder is to be mixed with scene paint it must be prepared separately, according to the directions given above, before it is added to the other pigment, otherwise it will separate out and flake off as soon as the paint is dry.

26. Oil Paints

Surfaces on small units, such as door frames and, particularly, furniture pieces, which have to stand the constant rubbing of the hands or clothes of actors or must be cleansed now and then with a wet rag, are frequently painted in oil.

Oil paint consists of two parts: the pigment, a powder similar to that used in water color scene paints, but ground more finely; and the vehicle, a liquid, the common ingredients of which are linseed oil and turpentine. The best work requires three to five coats. The first, called the "prime coat," is composed of much oil and little pigment and turpentine; the intermediate, the "body coats," contain more of the second and third elements; while the last, the "finishing coat," is made up principally of turpentine for a flat surface, or oil for a glossy. For the impermanent purposes of the stage, one or two coats of the same mixture is usually sufficient. A method very commonly employed in scene painting is to lay in the prime coat with an ordinary water color paint made up with a strong size (Sect. 8), followed with a coat of shellac (Sect. 27), and to use oil paint

in a single, final coat only. Shiny surfaces which reflect light are seldom in favor. The most serviceable oil medium, therefore, is ready mixed flat interior paint. It may be thinned, if necessary, by using a little turpentine, and made to dry more rapidly by adding a small amount of dryer.

To avoid streaking, oil paint must be applied with considerably more care than scene paint (water color). Stir the paint well before using. Break up any lumps in the bottom of the can and see that all the ingredients are thoroughly mixed. Clean the surface to which the paint is to be applied. Brush the paint on with long, straight strokes, evenly, smoothly, and not too thickly. Two thin coats are better than one thick one. Be certain that one coat is thoroughly dry before applying the second.

Oil paint can be laid over a tight surface of scene paint, but the reverse process is a little more difficult to do satisfactorily. Distemper does not stick well to a very smooth surface. To shellac the surface, first, however, will help to make the water color coat hold.

Oil brushes must be thoroughly cleaned with linseed oil or turpentine after every use and carefully kept separate from the water color brushes.

27. Shellac

Shellac, a spirit varnish composed of gum dissolved in alcohol, lends itself to quick and easy methods of imitating surfaced woodwork. A quite convincing mahogany panel may be created by painting a piece of profile board, or framed canvas, with white scene paint, graining it with black, and applying over this a couple of coats of orange shellac stained with a little powdered dye of a dark reddish brown color, such as Bismark Brown. If a really nice piece of work is to be done, one coat

should be allowed to dry thoroughly, and be sandpapered, before the next is applied. In the absence of dye a few teaspoonfuls of Burnt Umber and Venetian Red scene powder may be put into the shellac. Whole interiors are often done in this manner.

Shellac fulfills a number of other paint demands in an excellent manner. One of its first qualities is that of a water proofing agent. It is sold in two colors, clear and orange, is thinned with alcohol, and dries almost instantly.

Brushes used in shellac should be cleaned with alcohol immediately after service, and kept separate from water color and oil brushes.

28. Dyes

Pure aniline dye, or its substitute, the commercial "Diamond Dye," employed frequently for toning walls and draperies and occasionally for painting drops that have to be made very light and flexible, is prepared in the following way; mix one ounce of dye with water into a paste, add a teaspoonful of salt and a quart of water, and bring it to a boil. This is the standard method. A short cut is often taken in scene painting, however, by simply stirring the dye powder into very hot size water. If much painting is to be done with this medium, strong stock solutions of each color may be made up, kept on hand, and diluted with warm size water when required.

The following colors will be found useful. They may be combined to form a wide variety of intermediate tones. To lighten a dye, dilute it; to darken it, add more stock.

Brilliant Red
Wine Red
Purple

Blue
Green
Yellow
Seal Brown
Black

Dye may be applied with an ordinary scene brush. A little dye goes a long way; do not use it very heavily. Dye, unlike distemper, is not opaque. One color on the canvas may be modified by brushing another over it; but it cannot be fully blocked out once it is placed. Light areas can be darkened, but dark areas cannot be lightened. It is recommended, therefore, that when the artist is doing any piece of work at all elaborate, he lay in his pale tones first, and proceed from them to his deeper ones.

Analines are used quite extensively for "toning down" scenery painted in the ordinary way. If the walls of an interior are too lively, for instance, they may be grayed down quite effectively by spattering them lightly all over with black or blue analine (Sect. 16).

In an emergency in regular scene painting, whiting may be tinted with a little dye to take the place of some color run short. Seldom very satisfactory, however, the use of this method of mixing pigments is not to be encouraged as a regular practice.

Brushes used in dye cannot be thoroughly cleaned by being simply rinsed in water. The bristles, which take up a considerable amount of color, must be "bled" by being soaked for several hours in a pan of whiting and water.

29. Pigments Under Stage Lights

It is necessary to keep the lighting scheme of a production in mind while painting scenery. Not only the intensities of pigments are changed under stage illumination but often their

hues as well. Blue is one of the most conspicuous variants. Under straw and amber (yellowish lights, complementary to blue), which are apt to predominate in most interior scenes, an object painted dark blue tends to become black, while one of light blue turns toward gray. To appear normal, therefore, this color must be exaggerated somewhat. Yellow, on the other hand, must often be softened. Because so much depends on texture, the purity of gelatine mediums and the brilliance of illumination, it is difficult to give any definite rules for the selection of pigments.

The theory of the effect of colored lights on various pigments is discussed in a later section of this book (Part Two, Ch. VII, Sects. 4–8).

CHAPTER VII

THE ASSEMBLING AND SHIFTING OF SCENERY

1. Introduction

As has already been remarked, one of the first requisites of good scenery is that it be designed for ready shifting. An audience pays money at the box office to see a performance, not intermissions. The latter should, therefore, demand as little attention as possible. In presenting one scene of a play an effort should be made to arouse the interest of the audience and lift its emotions to such a height that the audience will be carried over the dead interval needed for rest and change of scenery and be influenced to begin the next scene with a warm and friendly feeling. A long or noisy shift makes this effort utterly futile. No change, however difficult, should occupy more than twelve minutes at most. Ten minutes is the average intermisison between acts, and two to four, the average between scenes within acts. If there are many scenes, the time required for intra-act changes should be cut to the absolute minimum.

It will readily be seen how necessary is the planning of methods for handling scenery during the periods in which it is put together and taken apart ("setting" and "striking"). As far as possible, these methods should be devised before the units of each set are built. Most of the time and temper so frequently wasted in refitting awkward pieces to the mechanical demands of the stage could be spared by a little more thoughtfulness on the part of the person who lays out the working drawings (Ch.

III, Sect. 5). Efficient assembling and shifting does not, however, depend alone on the construction of the scenery: it depends also on the arrangement of the stage.

2. The Requirements of the Stage for the Efficient Handling of Scenery

To design a stage for the most effective handling of present-day scenery requires a fine knowledge of engineering principles. The stage must be nicely proportioned and carefully organized in order to give a maximum of mechanical service in a minimum of space. No more complex in structure than some of its predecessors, frequently not so much so, the modern stage is considerably better planned for economy and flexibility than the older ones. The degree to which it may be called "modern" clearly does not depend upon its size and complexity nor the number of scene-shifting "tricks" it can boast. It depends on something more significant—its adaptability to the specific technical needs of each new play. Stages in this country are comparatively small. Most of the "trick" devices about which so much has been written require room which can be ill afforded. For that reason, over elaborate machinery is apt to defeat its own purpose and become a hindrance rather than a help. Flexibility and expansiveness are the first two essentials of good equipment. In the following sections are described some of the more common methods of assembling and shifting scenery on the adaptable type of stage.

3. The Methods of Lashing and Bracing Scenery

Two flats placed edge to edge are bound together by means of a system of "lashing" (Figs. 22 and 48) described in Chapter

IV, Section 10. The lash line, attached to the right upper corner of the flat on the left as one faces the back of the scenery, is grasped with the right hand, tossed up and over the left upper lash cleat on the flat on the right, back over a cleat on the first flat, then carried down over a lower one on the second, back

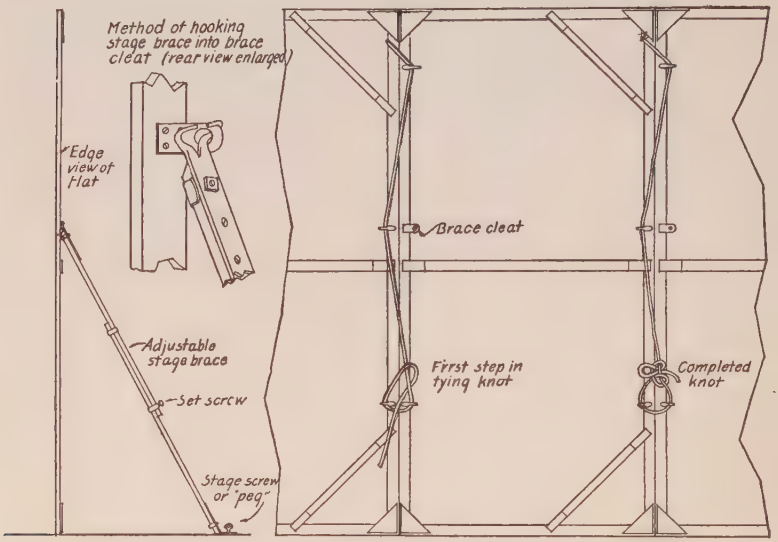

Method of hooking stage brace into brace cleat (rear view enlarged)
Edge view of flat
Brace cleat
Adjustable stage brace
Set screw
Stage screw or peg
First step in tying knot
Completed knot

Fig. 48. The Methods of Lashing and Bracing Scenery

See Fig. 22. Scale, $\frac{1}{4}'' = 1'-0''$.

to the first, and so on down to the last cleat on the right flat. It is carried over this cleat, around the cleat opposite it on the left, and back to the right. The free end of the line is now passed under the prostrate portion and pulled down snugly to tighten the lashing. While the left hand holds the rope taut, the right hand lifts the free end and passes a loop of it under the prostrate portion once more to tie a slip knot. To loosen the lashing it is necessary only to pull the free end of the line.

Stop cleats, or small mending plates, are frequently placed on the edge of a flat which must be lashed to another to form a corner.

Flats needing special support, such as those on the edge of a set, in the center of a long straight wall, or holding doors or windows, are made secure by propping them from behind with stage braces. In each position where this is necessary the brace (made of two lengths of 1″ x 1″ wood held between clamps, and fitted at one end with a forked iron hook, and at the other with an iron heel) is hooked into a brace cleat placed on any convenient part of the flat 8′-0″ or more from the floor; it is twisted so that its prongs clinch the plate as shown in the enlarged detail Figure 48; and then it is pegged firmly to the floor with a stage screw. The brace, which may be extended open to about twice its length when closed, is held at the proper adjustment by means of a set screw placed in one of the clamps. Stage braces can be ordered from J. R. Clancy, Inc., his agents, or any other firm dealing in theatrical hardware. (See addresses of Stage Equipment Companies at the end of the book.)

4. The Methods of Bolting and Hinging Scenery

Heavier units, demanding strength, such as stairs, platforms and other built pieces, and certain lighter units which cannot conveniently be lashed, are fastened together by means of carriage bolts and wing nuts, or loose-pin back flaps and wire pins. The methods of using this attachment hardware are described in Ch. IV, Sect. 10 and under the construction of the various units which usually require them. On pieces of scenery which have to be put together or taken apart quickly the bolts or hinges must not only be securely attached but must be in readily accessible places.

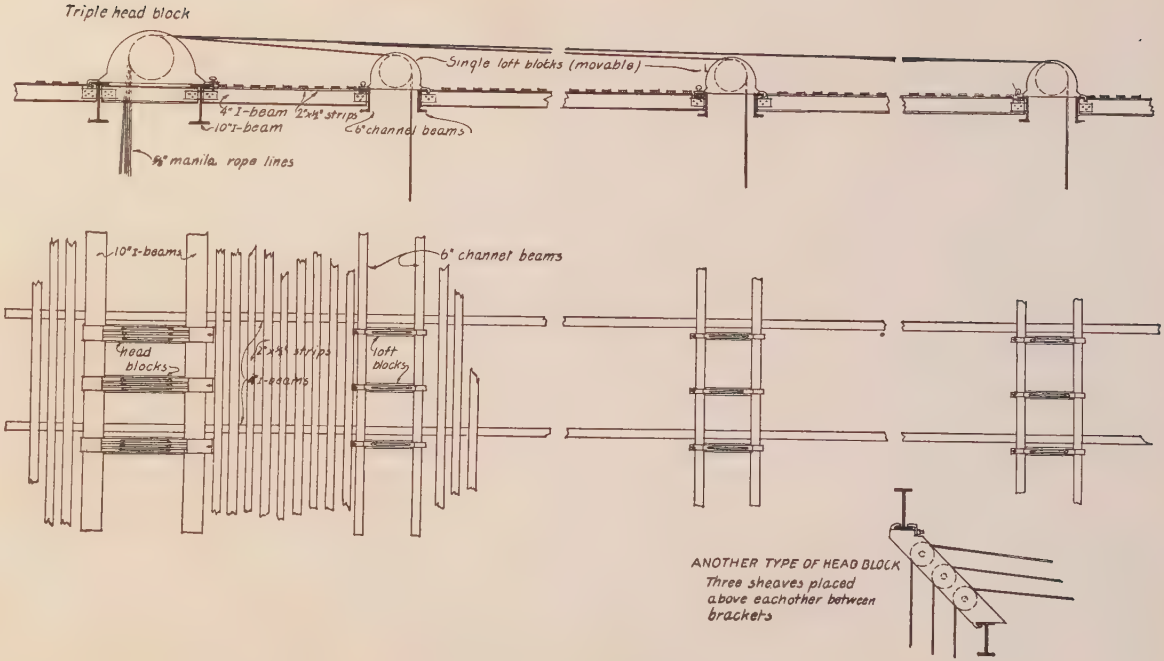


FIG. 49. THE CONSTRUCTION OF THE GRIDIRON

Section and plan. Scale $\frac{1}{4}'' = 1'-0''$.

5. The Gridiron and the Fly Floor

In order to fly scenery it is necessary to have some arrangement for hanging ropes from above. Every well equipped stage has a gridiron (Ch. II, Sect. 2) which extends over the entire working space and is built high enough to permit drops to be lifted completely out of view of the audience (Figs. 49 and 50). The fly space on some professional stages reaches over 100 feet above the floor. The grid itself is constructed as a skeleton framework of steel I-beams, or wood beams, which is supported by the side walls and often vertical hangers from the roof. It is covered with an open lattice-work of steel strips, and it is slotted from front to back at regular intervals to accommodate the fly ropes. The slots are commonly placed about 15′-0″ apart. A narrow stage will have four slots, a wider one six or more. Above each of these slots, except one, are bolted large steel protected sheaves called "loft-blocks"; while above the last slot, situated directly over the fly gallery, are set up multiple sheave frames called "head blocks."

Each set of blocks on an average sized stage (with a proscenium opening say 20′-0″ to 30′-0″ wide), generally consists of three loft blocks and one head block arranged in a row at right angles to the slots and parallel to the proscenium wall. A "set of lines," made up of ½″ to ⅝″ manila ropes (depending on the load), is attached to the center and the two ends of a hanging piece of scenery, passed over the three loft blocks directly above and the common head block at the side, then brought down and tied off on the row of belaying pins, the "pin rail," on the fly floor (Ch. II, Sect. 2, and Fig. 50).

The fly floor, from which all the fly ropes are controlled, is a narrow floor, sturdily constructed, placed along one of the side

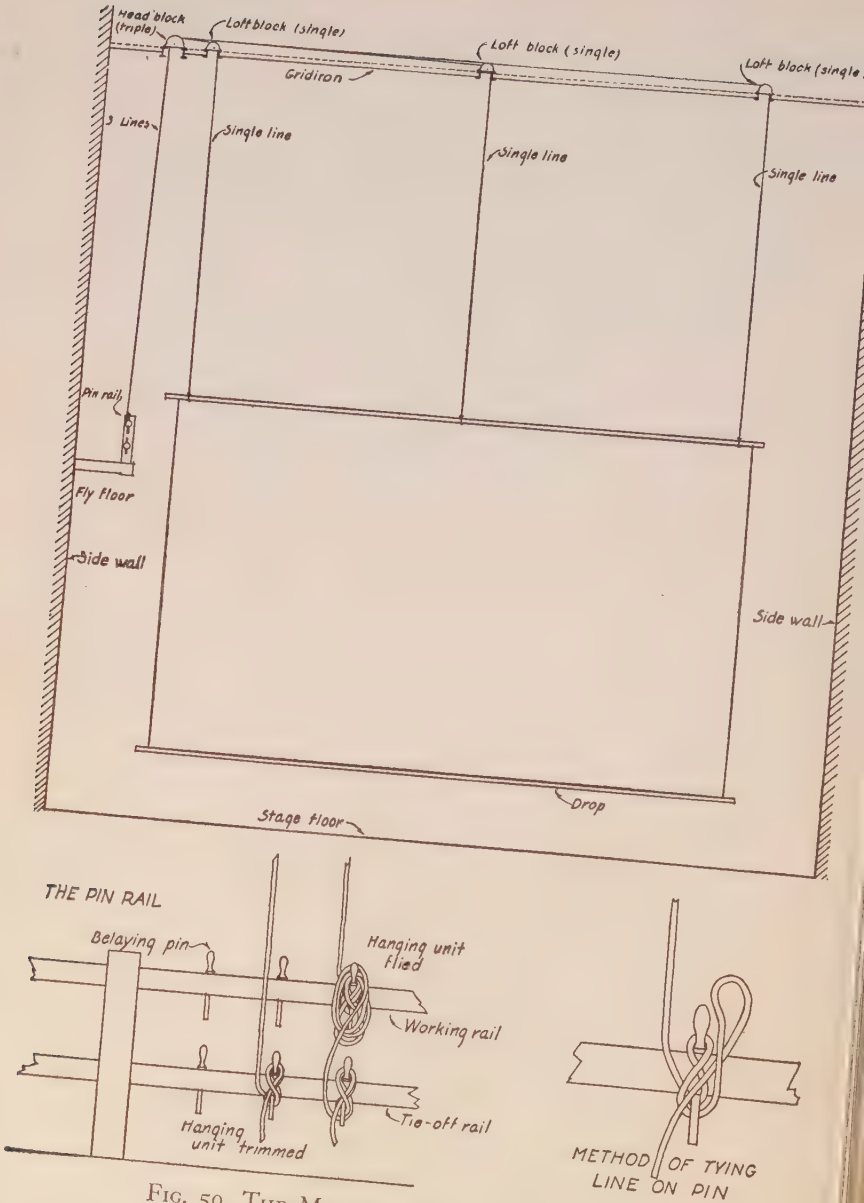


FIG. 50. THE MACHINERY FOR FLYING SCENERY

A general view of the gridiron and the fly floor, looking toward the rear wall of the stage (scale $\frac{1}{16}'' = 1'-0''$) and a detailed study of the pin rail on the fly floor, showing the method of tying lines (scale $\frac{1}{4}'' = 1'-0''$).

walls of the stage, between the proscenium wall and the rear wall, some distance from the floor. It is situated high enough to clear all standing scenery—frequently 20′-0″ to 30′-0″ in the air. The pin rail, to which the fly lines are attached, is a double row of 17″ to 21″ hickory, or iron, belaying pins—commonly just short pieces of 1″ pipe—stuck through about 8″ wooden beams or 5″ iron pipes running the length of the gallery and supported by heavy wood or channel iron posts. The two rows of pins, set on the on-stage side of the gallery, are arranged one above the other.

A well equipped stage has 15 to 30 or more sets of lines, with corresponding pins, placed about 9″ apart and numbered from the proscenium back. The complete system of ropes, blocks, and belaying pins is commonly termed the rigging."

6. Some General Methods of Flying Scenery

A line is attached to a drop, or other hanging piece, by tying it around the upper batten or into specially attached hanging irons. The three ropes in a set are called respectively the "short," "center," and "long line" as they are fastened to the near end, middle and far end of the unit of scenery from the point of view of the flyman. The knots (Fig. 51) used in making the ropes fast to the scenery must be those which combine absolute security with ease in untying. The bowline is commonly used for straight lifts, and the clove hitch for horizontal and bias pulls. If a quick attachment (*temporary* only) is to be made on a light piece of scenery, the slip knot may be employed. This knot, which will not hold well on a batten, is useful only for tying a line into a ring or onto another line.

On units which have no free battens to which the lines can

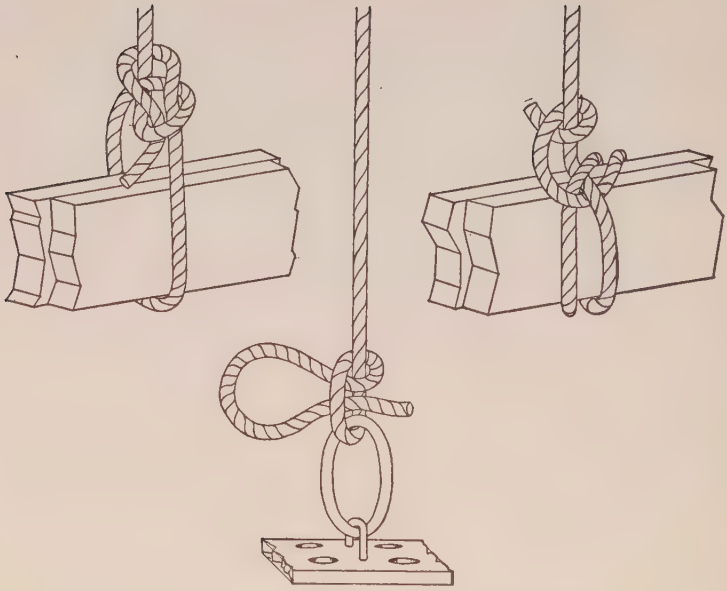


Fig. 51. Knots Commonly Used in Hanging Scenery
The bowline (left), the clove hitch (right), and the slip knot (centre).

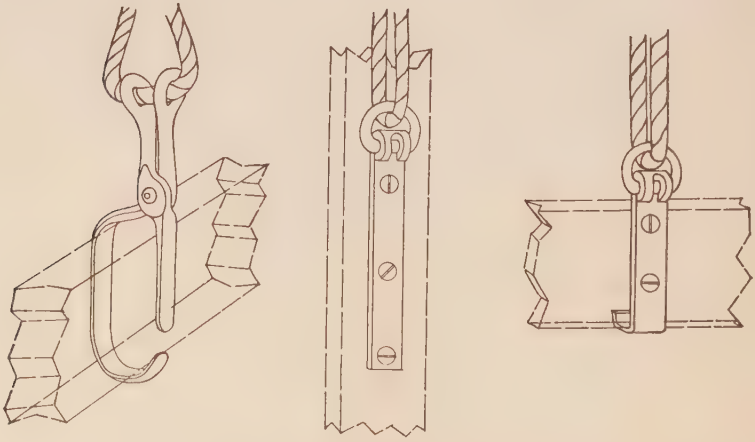


Fig. 52. A Drop Hanger and Two Types of Hanging Irons

conveniently be attached, hanging irons are used (Fig. 52). These are fastened vertically, ring end upwards, to the back of the unit, near the top, by means of $\frac{7}{8}''$, or longer, No. 9 screws. If the weight on each iron exceeds 50 lbs., one or more $\frac{3}{16}''$ stove bolts should be used with the screws.

The unit to which a set of lines has been attached is "flied" simply by pulling on the ropes. When it has reached the desired height, the ropes are made fast to a belaying pin. The method for "tying-off" is illustrated in Fig. 50. The ropes are first carried around the lower end of the pin (from left to right), then up, across and around the upper end (from left to right), down around the lower end and up again, about two and a half times. The set of lines is finally made fast by making a loop, turning it over, bringing it down over the top end of the pin, and pulling it tight, as illustrated. The free ends of the ropes are coiled and hung over the same pin to prevent their getting tangled with other ropes. For the sake of clearness in the drawing only one line in each set is shown.

There are two rows of belaying pins on the pin rail: the lower one for tying the drop, or other unit, at "trim," that is, when it is in position for the set, and the other pin for tying it when it is raised into the flies. This method of using the rail is found serviceable when a piece of scenery must be lifted and lowered during a performance. Trimming takes time which can be ill afforded during a quick shift. However, by using the two pins, this can be done beforehand. The lower tie remains permanent. When the appropriate scene arrives, the flyman loosens the ropes from the upper pin, lets them slide through his fingers, and when the slack is out he knows the drop or other hanging unit has come automatically to position.

Heavy pieces may be counterweighted by sandbags tied to the

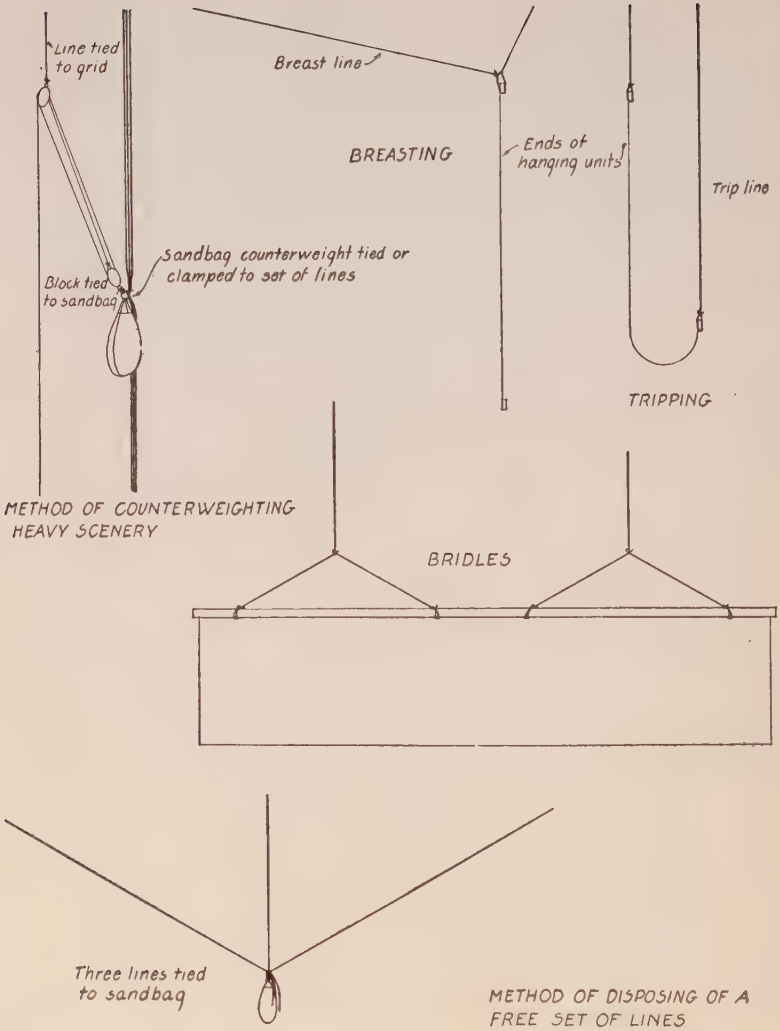


Fig. 53. Some Common Methods of Manoeuvring Hanging Scenery with Lines and Counterweights

lines just below the head blocks (Fig. 53). A whole rear wall consisting of three or more flats battened together may be balanced this way. A convenient clamp sold by J. R. Clancy, Inc. is often used in place of rope for attaching the heavy sandbag to the lines.

A wide piece of scenery, such as a drop, may, in an emergency, be flied on two lines, instead of three, by using "bridles" as illustrated in Figure 53.

On a stage equipped with a low grid a tall drop may be "tripped" out of sight by attaching, from behind, a second, adjacent, set of lines to the bottom batten. When both sets of lines are drawn, the drop is folded back and up into a space only half its height (Fig. 53).

Hanging units may be "breasted"—that is, pulled slightly forward or backward, or around on a bias—by having up-stage or down-stage lines attached to them (Fig. 53).

A unit is "trimmed"—that is, straightened so that it will hang squarely and without wrinkles—by having the short, center, or long line drawn up, or let out, a little. It is said to be "on trim" when it is in exactly the right position for use on the stage.

A small sandbag should be tied into every set of lines not fastened to scenery to prevent the ropes being pulled through the blocks when drawn up out of the way, and to force them to come down again with their own weight when released.

A word of caution. *Be sure that all hardware and knots used in flying are secure.* Some serious accidents have resulted from pulleys or hanging irons or sandbags breaking loose during a performance. Examine ropes from time to time for signs of wear. Safety is the first law of the stage as it is everywhere else.

7. Some Specific Methods of Flying Scenery

A drop or a border is flied by tying a set of three or more lines to its upper batten in the manner described in the preceding section.

A ceiling piece is suspended on two or three sets of lines, and lifted away or lowered to the standing set in the manner explained in Chapter V, Section 10.

The larger types of cycloramas unless specially rigged, like the one in the University Theatre at Yale, are generally too awkward to shift during a performance. All flying of other scenery has to be done inside of them. The smaller forms of cyclorama, however, are moved very simply. The rear batten is tied to a full set of lines and the down-stage ends of the arms to another set of two lines. If there is no scenery above to foul, the whole thing can be lifted straight up by drawing both sets of lines together. If the cyclorama is of any considerable size, however, this method of handling requires the full stage room, or, at least, the major part of it. There is another method, which permits flying the frame, canvas and all into a space little larger than that occupied by a drop. Two adjacent sets of lines are employed. The two-line set attached to the down-stage ends of the cyc-arms is tied on a permanent trim, and the actual flying is done by the rear set alone. When this is drawn, the back, or curve of the U-shaped frame, ascends first, while the arms fall down and back against the body of the cyclorama; then the whole thing is taken up as one flat piece. When the cyclorama is dropped, the permanently tied two-line set, which remained in slack while the piece was in the flies, tightens, and automatically pulls the arms back out into position. If the cyclorama unit is quite heavy, it is important to see that it is ade-

quately hung. Extra lines may have to be installed for safety.

To speed up the setting and the striking of a scene a complete back wall is frequently hung on a set of lines and flied like a drop. The several flats (single or hinged—see Ch. V, Sect. 4) which compose the wall are first laid flat on the stage, edge to edge, face downwards, and fastened together to make a single rigid panel by placing two or more long battens, called "stiffeners," across the back. They are fastened to the stiles of the flats by means of long screws or bolts, never nails. Ropes are tied into hanging irons attached at strong points (the center and two ends) to the back of the combination, and the wall is then raised and lowered as a unit. A side wall, also, may be flied in this way, by tying to it single lines from an up-stage and a down-stage set. A whole box interior, with three walls, can, on occasion, be lifted from the stage as one piece by using one full set of lines to support the back, and another set of two to support the two front corners.

Heavy units should be counterweighted by large sand bags tied to each set of lines just below the head block, as described in the preceding section and illustrated in Figure 53. If the wall of an interior which must be placed under the edge of a ceiling is to be balanced in this way, a small auxiliary block and tackle will have to be attached to the sand bag to lift the latter slightly, and so give some slack to the fly ropes when the wall is in position on the floor, in order not to foul the overlapping ceiling.

Canvas tree trunks and light columns may be suspended on single, independent lines which, in this employment, are termed "spotted" lines.

If the emergency demands it, furniture and other properties may also be flied. As a rule, however, it is not wise to play too

many tricks with the fly system. An overloaded grid is not the safest of things under which to carry on a performance.

8. The Counterweight System

In many of the newer theatres the fly gallery has been omitted

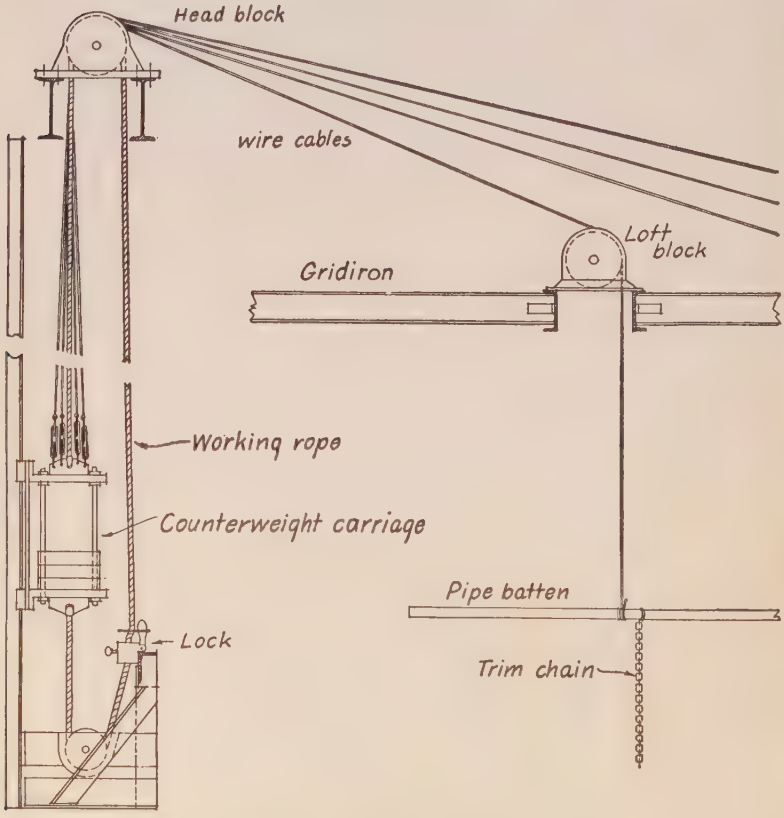


Fig. 54. The Counterweight System. A Unit

By this system hanging scenery is handled from the floor of the stage instead of from the fly floor.

and all flying is handled with a *Counterweight System* [1] operated from the stage floor (Figs. 54 and 57). In the unit form a pipe batten parallel to the proscenium wall and to the floor is attached to small steel cables, which pass over loft blocks in the grid—in the same arrangement as the manila rope flying system (Sect. 5)—over a common headblock at the side, and down to a metal carriage with adjustable weights, which slides up and down the wall in a vertical track. The three or more sheaves (pulley wheels) for the cables and the one for a manila rope, which compose the headblock, revolve side by side on a common shaft. The manila operating rope is fastened to the top of the sliding carriage, passed up and over its sheave in the headblock in the grid, down and under a single block near the stage floor and up again to the bottom of the carriage. The latter, pulled up or down by this "endless rope," in turn lifts or lowers the pipe batten it counterbalances. Scenery is attached to the pipe by means of trim chains. When a piece is flied to the proper height, the operating rope is fastened with a patent clamp lock. The balance weights are usually placed on the carriage from a narrow loading platform under the grid (see Fig. 57).

The most up to date stages today are equipped with both a counterweight system and the older rope system (Fig. 55). The combination permits a flexibility of control impossible with one system alone.

9. Flying on Small Stages

On small platform stages where there is no possibility of constructing a regular gridiron a makeshift can usually be arranged

[1] The "counterweight system" must not be confused with the use of counterweighting sandbags in the older method of flying scenery (see the two preceding sections and Fig. 53).

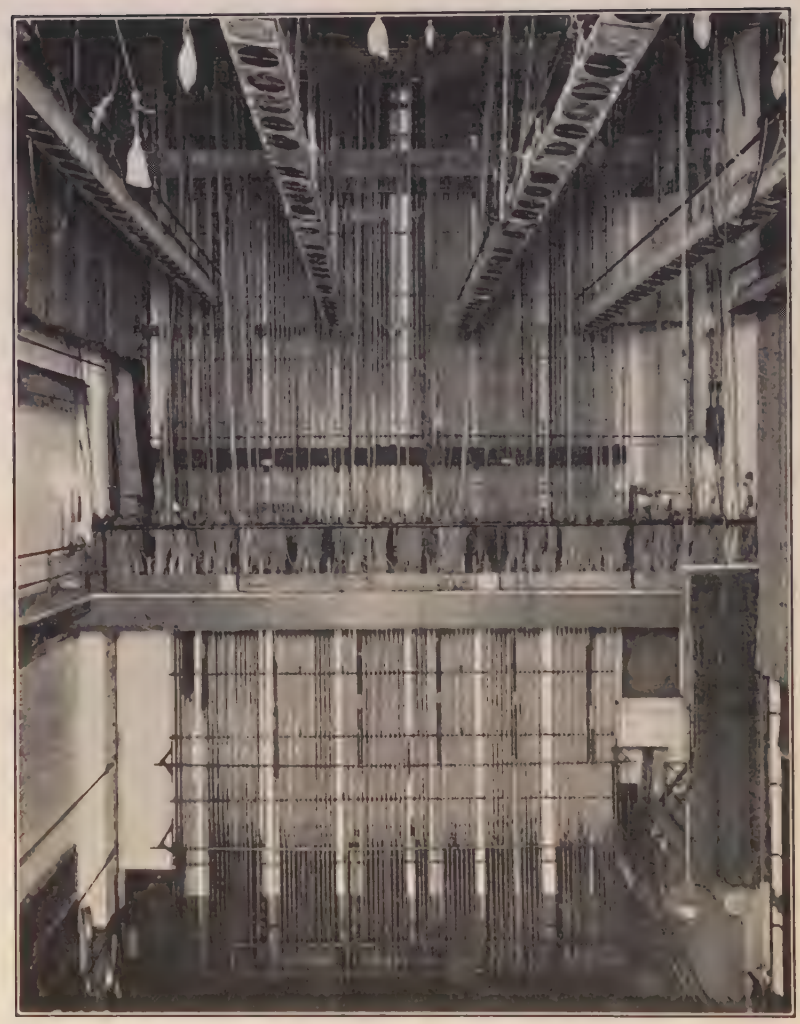


FIG. 55. A COMBINATION FLY SYSTEM

Rigging installed on the stage of the Erlanger Theatre, Philadelphia, by Peter Clark, Inc., New York. This arrangement for flying scenery, which combines both the older manila rope system, handled from a fly floor, and the newer counterweight system, operated from the stage floor, gives a degree of flexible control over hanging stuff impossible where either system is used alone.

in the form of a few stout pulleys fastened securely to beams in the ceiling. As a minimum, there should be two sets of pulleys to take care of the front and back edges of the ceiling, one to swing the pipe batten holding the front lighting units, and another to support the sky drop up stage. If the scenery is light, the

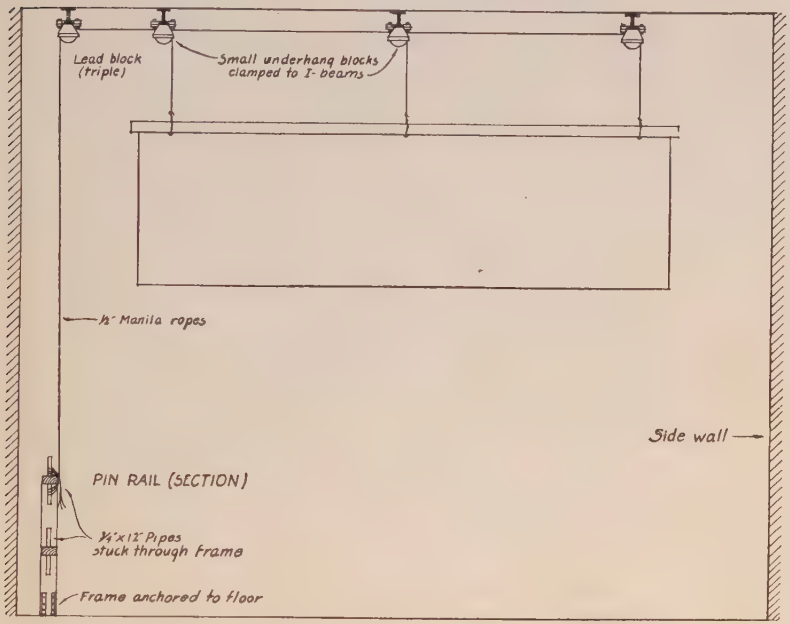
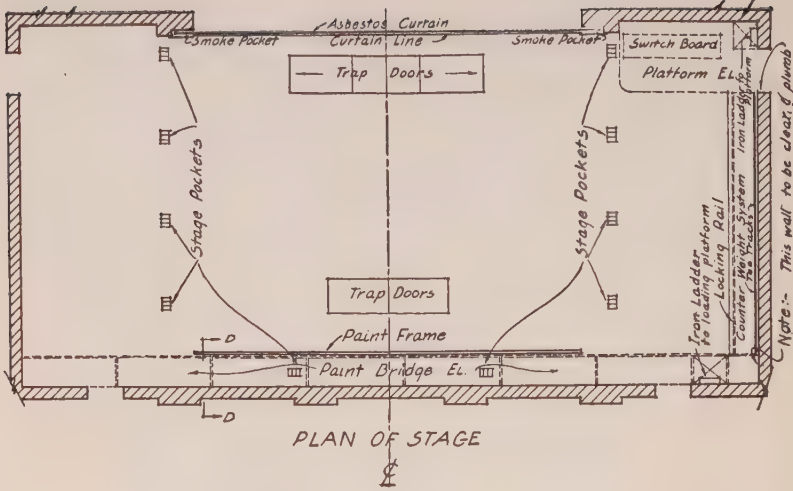


FIG. 56. ONE METHOD OF RIGGING A SMALL STAGE WITH A LOW CEILING

lines may be tied off on a row of common lash hooks fastened to a board nailed to the wall on the side.

A little more costly, but a considerably stronger and more generally satisfactory, substitute for a grid on a small stage may be had by installing a system of light steel I-beams and underhang blocks (Fig. 56). Four beams (about 4″), cut long enough



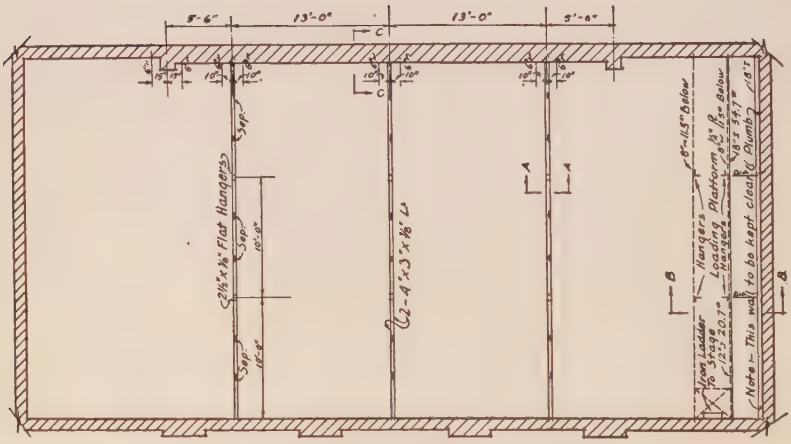
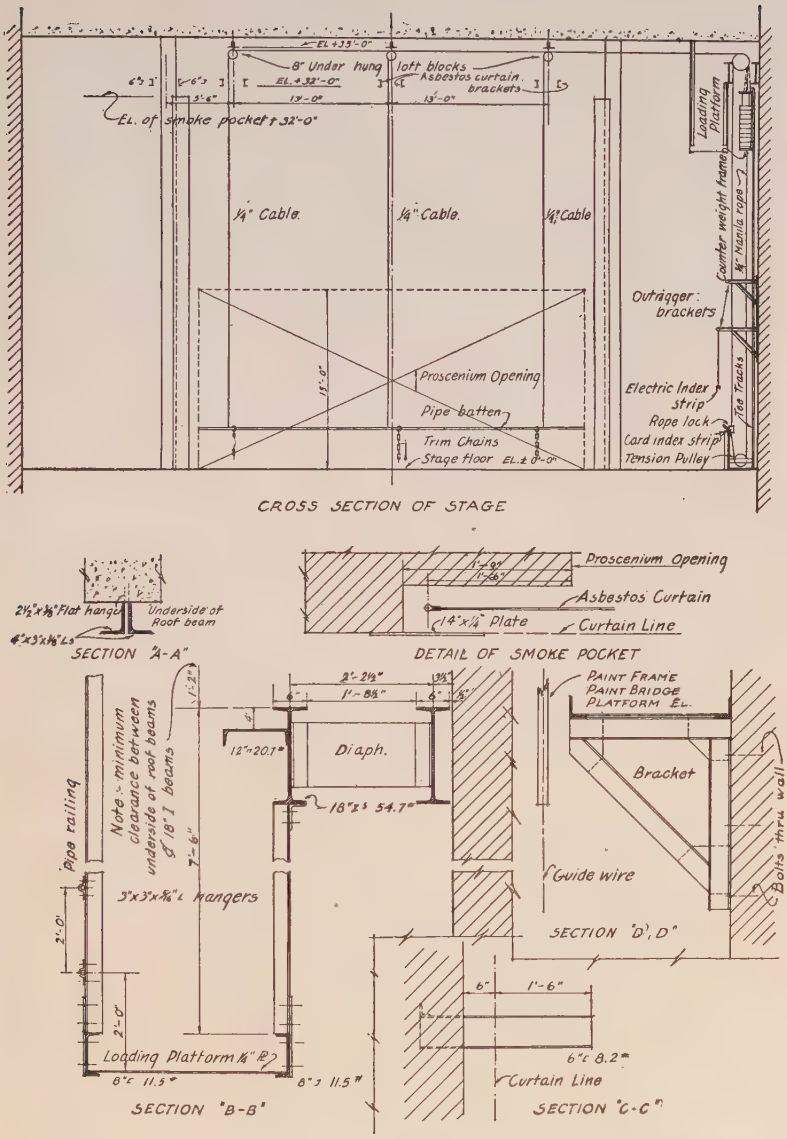


FIG. 57. MODERN RIGGING ON A HIGH SCHOOL STAGE

A counterweight system and other features of a thoroughly modern equipment installed by Peter Clark, Inc., New York, on the stage of the



Newark High School, Newark, N. J. The set of plans on these pages were redrawn from records in Mr. Clark's office.

to reach the full depth of the stage, are placed against the ceiling and secured into the front and rear walls. One beam extends back from a point above the center of the proscenium opening; two others from points about half way between that and the side walls; and the fourth from a point near the right or left side wall of the stage. Standard steel underhang blocks with 4″ sheaves are clamped and bolted to the lower flanges of the I-beams in the same general arrangement of parallel "sets" as that employed in the lay-out of a regular grid (Sect. 5). Single blocks are attached to the three beams in the center, and tripple blocks to the beam at the side.

A modified pin rail may be constructed by sticking 12″ lengths of ¾″ pipe through 2″ x 4″ wooden framing anchored securely to the floor. This framing should, of course, be placed directly under the beam carrying the triple blocks.

The lines should be ½″ manila ropes. Cotton rope can be trusted only for the lightest of loads.

If the ceiling of the stage is low, a drop may be flied out of sight either by "tripping" it, as described in Section 6, or by dropping it to the floor, rolling and tying it, and lifting it once more out of the way.

10. Some Special Shifting Devices

Practically all of the problems of shifting scenery can be handled quite satisfactorily with very simple equipment. Most of the novel shifting devices, such as hydraulic elevators, revolving tables, sliding platforms, tracks and automatic flying systems, have found little favor on the crowded stages of this country. They tend to prescribe the type and form of scenery handled by them. This is especially true on small stages. Unless

space permits their being completely ignored when types and forms of scenery which are not readily handled by them command the scene, as has already been said (Sect. 2), over-elaborate machinery tends to defeat its own purpose and become a hindrance rather than a help. A few of the simpler short-cut devices which do not destroy the flexibility of the stage, however, have occasionally proved to be very helpful. The "wagon" described in the following section, for instance, has been a very valuable assistant to the shifting crew several times in recent years. Such devices should be considered, nevertheless, as special investments for particular plays rather than as permanent adjuncts of the stage.

11. The "Wagon"

The "wagon" or "truck," one of the few scene shifting "tricks" really favored by stage technicians in this country today, has been used with much success for rapid changes in a number of recent New York productions, including: *An American Tragedy,* the revival of *Beyond the Horizon,* and *Congai.* In principle heavy groups of units are simply mounted on very low platforms fitted with casters and rolled into place for quick assembling and breaking—thus saving the considerable time and effort which would be required to put them together in smaller parts. Whole scenes are sometimes mounted on trucks. This last practice, however, is seldom indulged in on the stages of this country because of lack of room.

An ingenious use of the wagon system was employed in mounting the 1927 production of Eugene O'Neill's *Beyond the Horizon* (Fig. 58). In the first production some years before, the last scene had to be omitted only because the scenery could

not be changed in less than five minutes. This wait, almost at the end of the play, would have been disastrous. Mr. Cleon Throckmorton, who designed the settings, solved the problem for the second production by placing each of the two scenes—one, the interior of the farm home, and one, an exterior representing the brow of a hill—on a platform 6″ high and just large enough to carry the body of the setting. This platform mounted on ball-bearing castors was rolled up to a permanent platform, 6″ high and 8′-0″ deep, built on the stage floor just behind the footlights. The permanent platform was used as playing space for both scenes, thus doing away with the necessity of following the continental practice of carrying the entire stage floor on each truck. In the interior scene, two end wings, which folded upon the truck when it was not in use, were swung out to join the edge of the proscenium, when the set was rolled into position, to complete the walls on the sides. In the exterior scene a sky drop and two returns were used to mask the view at the back and sides.

Because each wagon carried all properties necessary to the setting mounted on it, the time occupied by a shift was only that required to roll away one platform and bring up the other. The last change was cut from five minutes to less than one.

In the more recent Sam Harris production of *Congai,* by Messrs. Hervey and Hildreth, Mr. Throckmorton, designer for this play also, made use of much the same plan, except that—due to the fact that there were six complete scenes—he was unable to mount the body of each scene on a single truck. Side and back walls and porches of the interior scenes, and the various units of an elaborate Indo-Chinese street scene, were placed on a number of rectangular and triangular platforms and rolled together, according to the proper plan, as each scene was set.

The most extended intra-act change by this method occupied only two minutes. Without the help of wagons the same shift would have required eight or ten minutes.

The general construction of a "wagon" is illustrated in Fig. 59. In the unit form 1″ x 6″ tongue and groove white pine

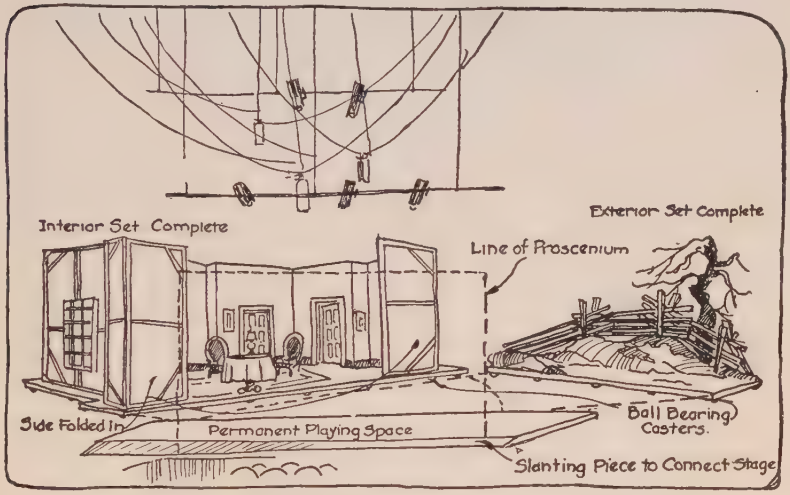


Fig. 58. Scenery on "Wagons"

The method by which the problem of shifting quickly an interior to an exterior scene was solved in the 1927 revival of Eugene O'Neill's *Beyond the Horizon*. The sketch is by Cleon Throckmorton.

boards are screwed to a frame of 1″ x 4″ battens, or heavier lumber (depending on the intended load) mounted on 4″ swivel ball bearing castors, which are bolted to it on the inside. The truck should stand just high enough to permit the castors to roll easily. A truck unit, which measures, at most, not more than 5′–9″ x 12′–0″ over-all, can be used singly to carry individual units, such as staircases; or it can be bolted to other trucks to form a larger platform on which a whole scene, such as one of

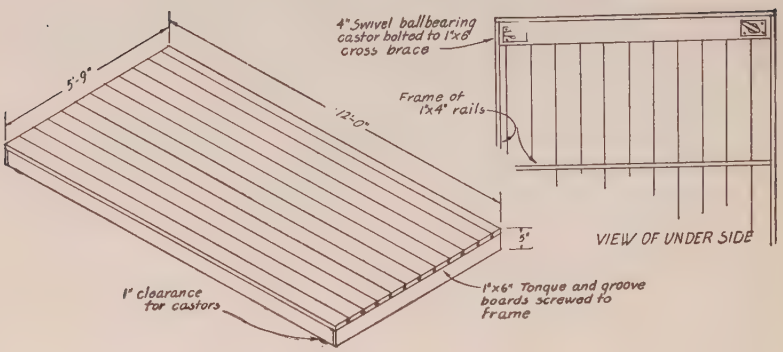

4" Swivel ballbearing castor bolted to 1"x6" cross brace
5'-9"
12'-0"
Frame of 1"x4" rails
5"
VIEW OF UNDER SIDE
1" clearance for castors
1"x6" Tongue and groove boards screwed to frame

Fig. 59. The Construction of a "Wagon"

The unit shown here is of maximum size. It may be built smaller, in practically any shape, to be used singly, or to be bolted to other wagons.

the settings of *Beyond the Horizon* described above, may be mounted.

The use of the wagon system for shifting scenery is a rather expensive one. It is not recommended for non-professional stages except in extreme cases. It serves its greatest purpose in the elaborate plays with many scenes which non-professional groups can seldom afford to produce.

12. Other Split-second Shifting Devices

There are a number of other fairly simple split-second shifting devices which are used in this country from time to time. Mention in passing might be made of the system in which the flats for a group of simple interior scenes are pivoted on two posts, one on each side of the stage, and opened in turn like leaves in a book. One "leaf" (made of two flats battened together) in each "book" forms a side wall of a set, while another folds out to meet a similar leaf from the other book to form

the back-wall. When the first combination is finished with, it is hinged back to make room for the second, and so on. A complete shift of scenery in a play recently presented at the Provincetown Playhouse was, in this way, cut from about four minutes to thirteen seconds.

Another method for reducing the time required for changing sets has been employed by the Theatre Guild in a number of its productions—notably *Marco Millions,* for which Lee Simonson designed the scenery (Ch. II, Sect. 9). A large, permanent frame is erected on the stage and the back and side walls of the various scenes, put together in large panels, are each in turn set into and fastened to this frame. This saves the considerable time which would be required for shifting if the units had to be lashed together and braced each time.

The two methods for shifting scenery described in this section are suitable, of course, for certain types of plays only. Mention of them as well as the wagon system are included in this chapter merely to suggest to the stage technician how invention may be applied to the problem of very rapid changes. For most purposes the standard flying, lashing, and bracing methods are quite sufficient. The full service of an ordinary grid and gallery equipment is seldom realized on the non-professional stage. A few lines and sand bags in the hands of an experienced stagehand can be made to perform a remarkable number of "stunts." The young scenic designer is wise to make himself completely familiar with standard methods in the theatre before devoting much of his time to the invention of tricks.

13. Setting the Scene

The exact plan adopted for the assembling of a group of scenic units varies, of course, with each scene. The following,

however, is the general procedure for "setting" (putting together) a simple box interior (Ch. II, Sects. 4–5). After the ground cloth (Ch. II, Sect. 2) has been laid, the ceiling is hung and lifted high enough to clear the flats; then the latter are lashed together in position, starting with one down-stage end and continuing in order around to the other, stage braces (Sect. 3) being used where necessary. Door and window frames, if they have not already been bolted to their flats, are put into appropriate openings, and clamped in place with their strap hinges. The ceiling is let down again, trimmed and tied off on the lower pin rail. Lastly, backings are placed behind doorways, and the sky drop or sky cyclorama (Ch. II, Sect. 11) is lowered. To "strike" (take apart) the scene, the ceiling is lifted two or three feet and a second tie in its lines made on the upper rail. The process of setting up is then reversed. An exterior scene is set and struck according to the same general plan.

When a group of scenic units are arranged on the stage for the first time, attention must be paid to proper placing and masking for good sight lines (Ch. II, Sect. 10). The tormentors at the sides must be brought on far enough to hide the edges of the down-stage flats; and the teaser at the top must be lowered to a position where it conceals the flies, the front edge of the ceiling (if there is one) and the overhead lighting units (Part Two, Ch. IV, Sect. 3 and Ch. VIII, Sect. 8). When the exact arrangement of a scene has been decided upon it is a good plan to mark its position at the corners by means of a little dark paint (oil if permanent, water color if temporary). This will insure accuracy in reassembling the scene.

All flats and other units should be numbered prominently on the back for quick reference, and be stacked in a definite order before the beginning of the performance. When they are set up

and struck during the performance they should be moved strictly according to this order. *Speed* and *efficiency* are two words which should never be lost out of mind wherever scenery is handled. Each shift should be plotted out carefully ahead of time and rehearsed until the station of every man and the sequence of his movements becomes absolutely clear. As far as possible, all methods and procedures should be standardized. "A place for everything and everything in its place" is a motto that might well be tacked up prominently on every stage.

PART TWO

STAGE LIGHTING

by

HUNTON D. SELLMAN

CHAPTER I

STAGE LIGHTING—ITS DEVELOPMENT AND FUNCTIONS

1. Introduction

Throughout two thousand years of theatre history, lighting was mere illumination with a single purpose—visibility. The Greek theatre, the Medieval stage of the mysteries and moralities, and the Elizabethan public playhouse used illumination from the sun, and when the theatre moved indoors, any methods of illumination that were available found their way into theatre practice. Torches, candles, oil lamps, lime light, and gas had their day. Of course, all of these methods of producing light were extremely ineffective, and the principal demand was for greater intensity. Control, too, when attempted at all, was exceedingly crude until gas came into the theatre as a means of illumination. What a tremendous forward step this was! No more candle snuffers interrupting intensely dramatic situations; control could be centralized in a single valve or separated into individual control at any point; and best of all, greater intensities of illumination could be achieved. This seemed to be the last word in stage lighting until electricity made its entrance. Again there was a formidable advance for brilliant illumination. The fire hazard, also, was almost eliminated when flimsy costumes and flapping scenery were no longer exposed to open gas flames. Soon after, when a means of control was discovered, electric lighting was firmly intrenched in the theatre

where it has remained with little fundamental improvement. At last, there was a means of producing brilliant illumination easily distributed and easily controlled but with no annoying gas fumes and comparatively little danger of fire. It is little wonder that stage lighting seemed to have reached its zenith. Visibility of the highest order had been achieved.

In addition to fulfilling this important function of illumination—visibility—lighting no doubt assisted occasionally in producing the ever popular spectacular effects which reached their height in France in the eighteenth century. It is strange, however, that throughout these several centuries of lighting theatrical performances indoors, there seems to have been no serious objection to the ineffectiveness of interior lighting compared to bright sunlight though there was the complaint that every means of interior lighting was insufficiently bright. Surely such men as Vignola and Leonardo da Vinci must have dreamed of lighting that would reveal the form of architecture and sculpture as the sun does. Whether they thought of a better method of lighting or not, lighting remained "the mere possibility of seeing," illumination for visibility, until the end of the nineteenth century.

2. Appia's Classification

Then, little more than thirty years ago, Adolphe Appia became interested in Wagner's operas. Appia designed settings for these operas and published them along with his theories of stage design and lighting in a book called *Musik und die Inscenierung*.[1] In this book he presented the revolutionary ideas that scenery should be made in three dimensions instead of being

[1] F. Bruckmann. Munich 1899 (out of print).

A setting for Ibsen's *Brand* designed by Donald M. Oenslager, instructor in stage design, and lighted by Stanley R. McCandless, Asst. Professor of Stage Lighting, as produced in the Yale University Theatre. This is an excellent example of lighting which is a part of scenery. The form on the cyclorama is cast with a Linnebach Projector. Notice the carefully placed highlights which give form to the steps.

Two well planned scenes from productions by the Department of Drama, Yale University. The setting at the top of the page designed by Frank P. Bevan for *Brief Candle,* by R. M. Powel, is an example of a finely lighted exterior. The play of highlights and shadows around the features and costumes of the actors, the background forms and the shapes cast along the floor is handled naturally and effectively. The warm light from the house on stage right is thrown in such a way as to balance the cool moonlight from the opposite side. The use of only twelve circuits was needed for the scene. The arrangement of the lighting in the scene designed by Frank P. Bevan for *Overlords,* by Talbot Jennings, illustrates how lighting may be made to emphasize the center of interest on the stage and bring out the natural forms of the actors and their costumes.

painted on a drop and that lighting must reveal the three dimensional nature of this scenery and the actor who played within it. Appia wrote of living light and living color; he called footlights the monstrosity of our modern theatre; and in one of his significant statements, he wrote, "Light is no more the mere possibility of seeing than music is synonymous with sound." Going more deeply into the problem of lighting as he thought it should be, he divided light into two classes: (1) *verteiltes Licht* or *Helligkeit* [2] which included light from borderlights, footlights, and striplights, the common lighting units of the nineties and (2) *gestaltendes Licht,* a kind of light unknown at that time, which might be translated *formative* or statuesque light.

Appia did not state that the lighting of the nineties should be wholly cast out, but he considered it inferior to his *gestaltendes Licht* which was to reveal the setting and the actors in their true form by casting natural shadows. The *Helligkeit,* the conventional lighting of the time, was to be used to soften shadows and to diminish excessive contrast caused by the new light. We are not far ahead of Appia today; so we may well take a basis similar to his for the present discussion of stage lighting for the non-professional theatre. First, however, some statement of terms must be made if confusion is to be avoided.

3. Terms

Illumination is the science on which the art of *lighting* is based. That statement really defines the principal terms which might be confused. *Light* is a general term which will often

[2] Appia apparently intended these two words to be synonyms. They can be translated "general illumination."

have to be used in its everyday sense. *Illumination* however will be used in the sense of light which is produced by apparatus such as floodlights or spotlights, while *lighting* will be considered as the final effect of using a distribution of illumination in a setting. *Lighting* is the artistic or aesthetic effect which one tries to achieve. *Illumination* is the means one uses for the achievement.

4. Classification

Illumination can be divided into two classes: (1) *General illumination,* which is usually produced by borderlights, is a diffuse distribution of light that casts no shadows. It is illumination which can vary in intensity and color but which has very little form. (2) *Specific illumination,* which is usually produced by spotlights, is illumination that is directed upon a restricted area. Specific illumination casts definite shadows, and it can have various forms as well as differences in intensity and color.

Now, there are certain functions which must be carried out before one can say that he has used illumination to arrive at his goal of artistic lighting. For purposes of discussion they have been listed here under the two kinds of illumination mentioned above, although some of the functions in one class are similar to those in the other. The purpose of classifying the functions in this way is to place before the reader a simple statement of the problems of stage lighting. The classification and short explanation of the functions follow.

I. General Illumination
- (a) Illuminates the actor and his environment.
- (b) Diminishes excessive contrasts.
- (c) Suggests natural phenomena.

II. Specific Illumination
- (a) Creates relief, true form, for actor and setting (makes them plastic, not flat)
- (b) Enhances the beauty of the setting by means of color, form, and pattern.
- (c) Carries out the intended psychological and emotional values in the play.
- (d) Directs attention to the center of interest.
- (e) Suggests natural phenomena.

5. General Illumination

(a) Illuminating the actor and his environment by general illumination seems simple enough, but the degree of intensity must be proper for good vision. Good vision demands that light be neither bright enough to cause painful or tiresome glare nor dim enough to cause difficulty in seeing. The color, no matter for what artistic purpose it is chosen, should be pleasing and restful to the eye. An example of an objectionable use of color is the using of an intense blue flooded over the entire stage for night scenes. It has a painful effect upon the eye and makes concentration of attention difficult for the audience.

(b) The diminishing of excessive contrasts is also accomplished by light and color. After the specific illumination for a stage set has been applied in form, color, position, and intensity, the general illumination is increased from black out to that degree of intensity which, in the judgment of the lighting artist, maintains a degree of contrast best suited artistically

and practicably to the demands of the production. The artist, in exercising his judgment about the degree of intensity, should not forget the first function of general illumination. If color is used in the general illumination, of course, the shadows will be colored. In painting, and indeed in nature itself, the color of the shadows goes toward the complementary of the highlights. Following this in selecting color for general illumination, one will achieve results in color compositions of unusual beauty.

(c) For suggesting natural phenomena, light and color are useful; steel-blue light for moonlight, a cold white light for early morning, a tint of yellow for midday sun, and pink and red for sunsets give us a suggestion of nature and the time of day.

6. Specific Illumination

(a) For creating relief, plastic form, for the actor and his environment, a concentrated beam of light cast from an ideal, predetermined position is necessary. This produces natural highlights and shadows in the actors' faces as well as in the various elements of the setting. Color, as stated above, finds a place both in light and shadow.

(b) Enhancing the beauty of the setting by means of color and patterns of light and shade through specific illumination is highly important. Colored light for stage decoration is as important as scene paint, for a combination of the two upon the scenery is what actually appears to the audience. The amazing difference between stage scenery first in daylight and then in colored stage light intended for it can be realized only by those who actually behold the transformation. Light and shade, as well as color, form a part of the decorative scheme by means of

masses of shadow and shafts of light arranged in a pattern or composition.

(c) Carrying out the intended psychological and emotional values in a play depends upon the subtle and artistic employment of light, shade, and color. A form in light, a shadow here, and a touch of color there, are insignificant in themselves, but they contribute toward the total effect, the atmosphere of the play, and the psychological effect to be produced upon the audience. The use of shadow and color to produce a definite emotional effect upon an audience or to symbolize certain ideas in drama has been common in the productions of such regisseurs as Max Reinhardt and Walter Hampden and in the designs of Robert Edmond Jones and Norman-Bel Geddes. A black costume for melancholy Hamlet is traditional; a green light for envious Venus and pure white for Diana are obvious symbols. Of course, romantic and classic drama offer greater opportunity for this use of color than realism and naturalism; but melodrama, especially the mystery variety, reeks with opportunity for the emotional effect of shadows. Some artists, no doubt, carry color symbolism to such extremes that their audiences miss most of it, but there are many tried and well known symbols which can be used effectively before any audience.

(d) Directing the attention of the audience to the center of interest is an important, but often neglected, function of specific illumination. That is, the units producing the specific illumination can be so placed and their intensity so varied during the performance that the brightest area at any moment will be where the center of interest lies. In this way the eye is compelled to follow the center of interest as the stage groupings change.

(e) Suggesting natural phenomena is done with the light and shade of specific illumination as well as with the light of general

illumination. Suggesting the hour of the day is a frequent demand. Suppose, for example, that the play to be produced is in three acts; the first, a morning scene, the second, an afternoon, and the third, an evening. The source of light suggesting the sun might be placed on the right for the morning scene; consequently, certain shadows would fall toward the left. By afternoon the sun would be on the other side; so the source of sunlight would be moved to the opposite side of the stage; the shadows, then, would be reversed. Moonlight in the third act might be from any angle compatible with good lighting design and good vision for the audience. Good lighting design, one must remember, does not require the photographic reproduction of nature, which too often becomes an end in itself. Nature should not be imitated, but merely suggested.

7. Conclusion

Thus, light, shade, and color, through general illumination and specific illumination can accomplish these important functions and create artistic lighting in the *mise en scene*. Light aids the actor in his interpretation of character, it enhances the beauty of stage decoration, and as an art medium *per se* it carries to the spectator the mood, atmosphere, and emotional effect of the drama itself. This chapter is a brief outline of what one can do with light if he has certain information and a limited but well selected supply of apparatus and equipment for control. In the chapters which follow, the essential information for lighting plays is presented first by reviewing the fundamentals of electricity and light. Without this information one can neither select lighting equipment intelligently nor can he use it effectively to achieve the results that have been mentioned here.

Following the discussion of electricity and light is a survey of the apparatus used to produce and control the kinds of illumination discussed in this chapter. Then the functions are elaborated upon by discussing at some length the important problems of light and shade and light and color. And last, the functions are applied to a definite problem to produce effective lighting. From this whole discussion a point of view and a method should be acquired. The non-professional lighting artist should be able to study a play and visualize an effect in light, not merely illumination in terms of borderlights and spotlights but something which grows out of the play itself and is a true expression of that play. He must think first in terms of this æsthetic effect, and then he must be able to create it in terms of apparatus. When one can do this effectively, he is beginning to become acquainted with this mobile, vital, dynamic medium of expression.

CHAPTER II

ELEMENTARY ELECTRICITY

1. Introduction

Many of the workers who are solving the problems of stage lighting in college and community productions have turned to lighting problems because of their previous knowledge of electricity and lighting circuits gathered elsewhere. There are others, however, those interested in scenery and costume and those directly interested in stage lighting but from a more æsthetic point of view, who wish to round out their knowledge by a consideration of the principles of elementary electricity. In order that this second group may feel as much at home with watt, volt, and ampere as they do with light, shade, and color, this brief chapter on elementary electricity and lighting circuits has been included. In the following chapters on apparatus and its use, we shall assume that the reader is familiar, at least to the extent of this chapter, with lighting circuits and the technical terms involved.

2. Voltage

The laws which govern simple electrical circuits are in general similar to those which apply to water flowing through pipes. Like water, electricity flows from a higher to a lower level of energy, and in each case there is a certain pressure which is the

result of difference in level. From the presence of a difference in level, called difference in potential, arises an electromotive force (e.m.f.) which causes electricity to flow. We measure this electromotive force by a unit named the *volt,* and accordingly, e.m.f. is often called *voltage.*

3. Current

Water moving in a pipe is called a current of water; likewise, electricity in motion in a wire is called an electric *current.* The rate of flow of an electric current in a wire is measured in units called *amperes.* If an hydraulic pump, which is developing pressure, has a complete pipe circuit connected to its outlet and inlet, the pump will cause a current of water to flow through this pipe circuit. The same thing happens in electricity. When an electromotive force, a voltage, is applied to a conducting circuit (copper wire, for example) a current of electricity will flow through the circuit.

A *direct current* is a current which always flows in one direction, while an *alternating current* is one that reverses its direction at regular intervals. The water analogy for a direct current is exactly the same as the pump circuit mentioned above. A pump circuit will also explain an alternating current. The piston of a valveless reciprocating pump pushes the water through the pipe circuit in one direction on one stroke, and on the opposite stroke it pushes the water through the pipe circuit in the opposite direction. This is an alternating current of water. The alternating current of electricity reverses in a similar manner, but the reversals usually occur with great rapidity. For example, the eye cannot tell the difference between a direct current and an alternating current of 60 cycles when either is pass-

ing through a lamp filament because the alternating current of 60 cycles is actually changing direction 120 times in one second.

4. Current and Voltage

The reader understands immediately that a greater hydraulic pressure is required to force a given amount of water through a small pipe than through a large one in a given time. Analogously, a higher voltage is necessary to force a given amount of electricity through a small wire than through a large one in a given time. In a given circuit, increasing the voltage proportionately increases the current. Furthermore, in an hydraulic circuit with the valve closed there can be pressure without flow of water; similarly, there can be pressure on an open electrical circuit. For example, a spotlight properly plugged in with the switch closed has a potential of 110 volts between the terminals of the lamp receptacle (socket) although no current will flow in such a circuit until there is a connection between these receptacle terminals.[1] If, however, we screw a lamp into this receptacle, the circuit is completed through the filament of the lamp, and current flows through the filament and through the entire circuit. Here, as in all such circuits, current is forced through by the impressed voltage maintained by a generator in a central power plant.

5. Resistance

Just as different pipes offer different amounts of resistance to the flow of water; so do wires of different size or of different materials offer greater or less *resistance* to flow of electric current. All materials have resistance, but wires used for electrical

[1] Terminals are usually screws or clips to which connecting wires are attached.

conductors are commonly made of copper because it is the cheapest material possessing low resistance. Materials having an extremely high resistance, that is, those which do not carry electricity at all, are called *insulating materials*. Common insulating materials used on the stage are porcelain, fibre, rubber, asbestos, and cotton fabric. Porcelain is used for receptacles, or sockets; fibre, for plugs; and rubber and cotton fabric, for covering wires.

The practical unit of resistance is the *ohm. A conductor is said to have a resistance of one ohm if a current of one ampere flows through the circuit with a pressure of one volt.*

6. Ohm's Law

There is a simple but very important relationship between the electromotive force (volts), the current (amperes) and the resistance (ohms) in an electrical circuit. This relationship called *Ohm's law* which applies to the whole or any part of an electrical circuit, can be expressed in this way: *The electromotive force is equal to the product of the current and the resistance*. Using the symbols E for voltage, I for current and R for resistance

$$E = IR$$

$$\text{or } I = \frac{E}{R}$$

$$\text{or } R = \frac{E}{I}$$

where I is expressed in amperes, E in volts and R in ohms.

Example I: Determine the resistance of a lamp which carries a current of 2 amperes flowing under an applied e.m.f. of 110 volts.

$$R = \frac{E}{I}$$

$$R = \frac{110}{2} = 55 \text{ ohms. res. of lamp.}$$

Example II: What current will flow through a dimmer or rheostat (see footnotes on page 222) having a resistance of 25 ohms if the applied voltage is 125 volts?

$$I = \frac{E}{R}$$

$$I = \frac{125}{25} = 5 \text{ amperes, current passing through the dimmer.}$$

7. Series and Parallel Circuits

Electrical circuits may be divided into two general classes: series and parallel, and all circuits found in practice consist of

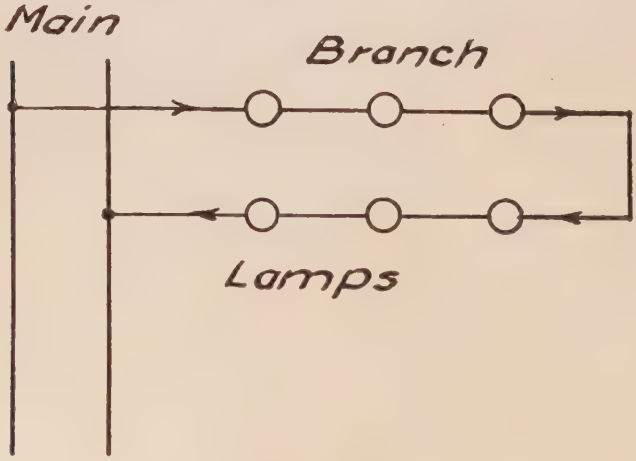


Fig. 1. A Series Electric Circuit [2]

Arrows indicate path of current.

[2] In all wiring diagrams throughout the text a large dot at the point of contact between two lines representing wires indicates an electrical connection. Where wires cross without this dot the wires are insulated from each other.

either series elements, parallel elements, or a combination of the two. A series circuit is one in which the current follows a single path through the several elements and has the same value in all parts of the circuit (see Fig. 1).

Problem. Each of the 6 lamps in Figure 1 has a resistance of 10 ohms, and the generator maintains an e.m.f. of 110 volts. Determine the current.

10 ohms per lamp x 6 = 60 ohms total resistance

$$\frac{E}{R} = I$$

$$\frac{110}{60} = I = 1.83 \text{ ampere current in the circuit.}$$

In a series circuit the applied voltage of the whole circuit is equal to the sum of the voltages across the components of that circuit. We can illustrate this with the same example. Each lamp was assumed to have a resistance of 10 ohms, and a current of 1.83 amperes was found to be flowing through it. Assuming for the moment that we do not know the voltage, let us determine the voltage necessary to maintain that current. The voltage drop across each lamp is, by Ohm's law, $E = IR = 1.83 \times 10 = 18.3$ volts. Adding the voltage drop across each lamp to get the total drop, or the total voltage the generator must maintain, we have 6 lamps of 18.3 volts each, $6 \times 18.3 = 110$ volts.

The resistance of a series circuit is the sum of the resistances of the components. This also was illustrated in the above example. Six lamps of 10 ohms each possessed a total resistance of 60 ohms. If the connecting wire were long (half a mile for example), it might have an appreciable resistance that would then be added to the total resistance of the lamps.

A parallel circuit, occasionally called a multiple or shunt circuit, is one whose elements are connected in such a way that the

current is divided among the several branches. That is, the current passing from the generator through the circuit and back to the generator will go through as many paths as there are branches in the circuit (Fig. 2). The parallel circuit is of great importance in theatre lighting, as well as in all interior lighting, because incandescent lamps are commonly connected in parallel.

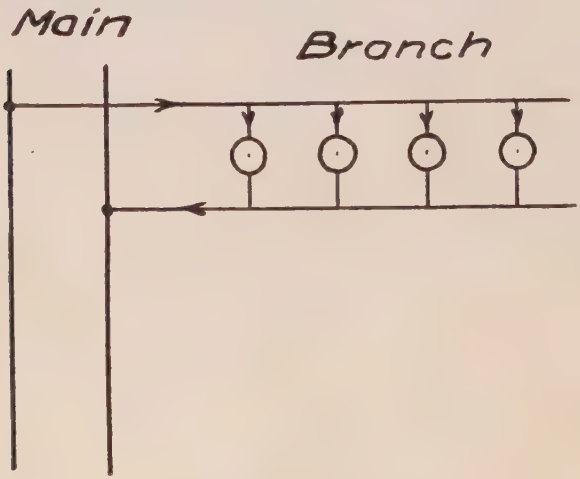


Fig. 2. A Parallel Circuit
Arrows indicate paths of current.

The voltage across the group of lamps connected in parallel (Figure 2) is the same as the voltage across each lamp, provided that the resistance of the connecting wires is so small that it may be neglected. This is certainly true in the usual theatre lighting circuits.

The total resistance of a parallel circuit can be determined by the formula,

$$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4} - \text{etc.}}$$

where R is the total resistance and r_1, r_2, r_3, r_4—are the resistances of the several parts. All are expressed in ohms.

Problem. Find the total resistance of the group of lamps shown in Figure 2, the component resistances being 10, 20, 25 and 100 ohms.

$$R = \frac{1}{\frac{1}{10} + \frac{1}{20} + \frac{1}{25} + \frac{1}{100}} = \frac{1}{\frac{10}{100} + \frac{5}{100} + \frac{4}{100} + \frac{1}{100}} =$$

$$\frac{1}{\frac{20}{100}} = \frac{100}{20} = 5 \text{ ohms, total resistance.}$$

Problem continued. Find the current through each lamp and the total current if the voltage is 110.

Applying Ohm's law to each branch of the above circuit we have:

$$I_1 = \frac{E}{R} = \frac{100}{10} = 11.0 \text{ amperes.}$$

$$I_2 = \frac{110}{20} = 5.5 \text{ amperes.}$$

$$I_3 = \frac{110}{25} = 4.4 \text{ amperes.}$$

$$I_4 = \frac{110}{100} = 1.1 \text{ amperes.}$$

The total current would be the sum of these or $11.0 + 5.5 + 4.4 + 1.1 = 22.0$ amperes. The same result could have been

found by applying Ohm's law to the whole circuit. In this case the total resistance computed would be employed together with the line voltage.

8. Power

Power is required to maintain a current of electricity whether it be direct or alternating. The practical unit of power is the watt, the product of volts and amperes.

$$P = EI$$

Watts = volts x amperes.

Since by Ohm's law $E = IR$, then by substitution $P = I^2R$.

Lamps are rated by the number of watts they consume at a definite voltage.

Example: 100 watts at 120 volts. This information used in the formula $P = EI$ gives the current passing through the lamp. Thus $100 = I \times 120$

or $$I = \frac{100}{120} = .85 \text{ ampere, current through the lamp.}$$

With this we are able to determine the resistance of the lamp.

Since $E = IR$

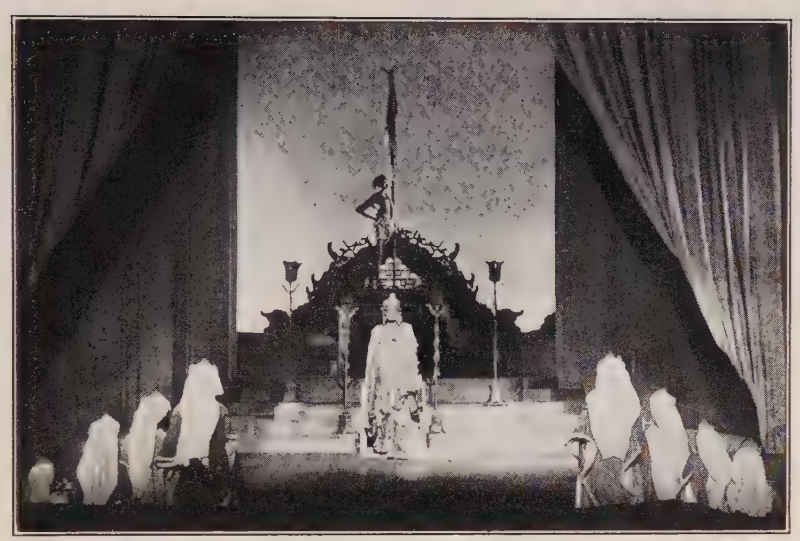
that is, $120 = .85R$

therefore, $$R = \frac{120}{.85} = R = 141.2 \text{ ohms, res. of lamp.}$$

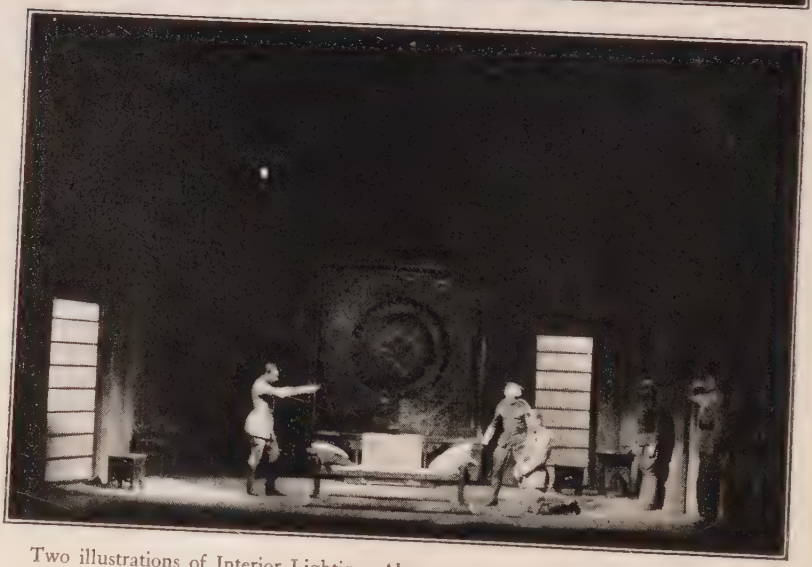
Example 2: What is the resistance of a 1500 watt lamp rated at 110 volts?

$$P = EI$$

$$I = \frac{1500}{110} = 13.6 \text{ amperes, current through the lamp.}$$



Two settings by Lee Simonson for Eugene O'Neill's *Marco Million,* produced by the Theatre Guild, which show very clearly how scenery, lighting, stage properties, and even the actors themselves, may be made to contribute to a single stage design.



Two illustrations of Interior Lighting. Above: a scene from Macgowan and Reed's production of Edwin Justus Mayer's *Children of Darkness,* set and lighted by Robert Edmond Jones; and below, J. Wong Quincy's *Peking Politics* set by Harold Helbenston and produced at the Yale University Theatre. Both scenes make use of motivated light. In the one above light actually comes through windows to make patterns on the fireplace and floor, but in the one below the light merely appears to come from the windows. Daylight is indicated in both cases.

since $E = IR$

$$R = \frac{110}{13.6} = 8.07 \text{ ohms, resistance of lamp.}$$

From these two examples it is clear that the greater the power consumed by a lamp, the greater the current which will flow through it, and the lower will be its resistance.

9. Application to the Stage

The problem of changing the intensity of illumination is of fundamental importance in stage lighting. The simplest method of changing intensity is accomplished by placing a *rheostat* [3] (a *dimmer* [4] in the technical language of the theatre) in series with a lamp or group of lamps (Fig. 3). A greater or less amount of resistance is added to the circuit by moving the variable contact represented in the diagram (Fig. 3) by the arrow (A). When the variable contact is in the position which places the very smallest part of the resistance in the circuit, very nearly the maximum current in the circuit is passing through this small part of the wire in the rheostat. The resistance wire of which the rheostat is made must be, accordingly, of such size that it will not overheat when the maximum current of the circuit is passing through it. A rheostat is rated in amperes, the maximum current which will not overheat it (it is also rated in ohms, total resistance). Obviously, when a larger part of the wire is included in the circuit, by Ohm's law, the current would be proportionally smaller.

[3] *Note.* An electrical instrument consisting of an insulated base on which is mounted a length of wire of higher resistance than the usual copper conductor and having terminals at each end constitutes an electrical resistance. In case the resistance may be varied at will the device is known as a rheostat. (Fig. 3).

[4] For a description of a dimmer, a rheostat made expressly for use on the stage, see Ch. V, Sects. 22–23.

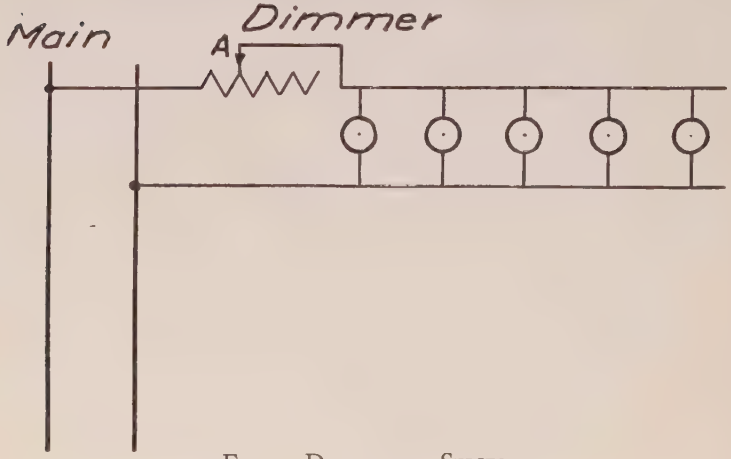


Fig. 3. Dimmer in Series
With group of lamps in parallel.

In determining the proper rheostat to be employed in a given instance, first, one must determine the current in the lamp circuit. This may be done as follows:

Problem. Suppose each of the 5 lamps in Fig. 3 has a rating of 100 watts at 110 volts, and we wish to know the current carrying capacity and the resistance of a dimmer capable of dimming these lamps out black.

The total lamp load is

$$5 \times 100 \text{ watts} = 500 \text{ watts}$$

then by $P = EI$

we have $500 = 110I$

$$\text{or } I = \frac{500}{110} = 4.5 \text{ amperes.}$$

This is the amount of current flowing in the line when there is no dimmer in the circuit. Accordingly, for this circuit we select a rheostat or dimmer with a rated capacity of about 4.5 amperes.

The other important consideration is to have sufficient resistance to dim the lamps black out. Knowing the voltage and the current, we can find the total resistance of the lamp load. Thus:

$$R = \frac{E}{I}$$

$$\text{therefore, } R = \frac{100}{4.5} = 24 \text{ ohms (approximately)}$$

It has been determined by experiment that the resistance required to dim a lamp black out is about three times the hot[5] resistance of the lamp. Multiplying 24 ohms by 3 we have 72 ohms which is the amount of resistance necessary to dim a lamp load of 500 watts. For this purpose we need a rheostat rated at not less than 4.5 amperes and 72 ohms. For the convenience of those who wish to determine quickly the resistance necessary to dim any ordinary lamp load, a curve has been included (Fig. 4) from which one may read directly the amount of resistance if the wattage of a lamp or group of lamps in parallel is known. Suppose it is required to dim a load of 1700 watts. From the point of intersection of the line representing 1700 watts with the curve, trace horizontally to the axis representing resistance. The reading on this axis is seen to be 25 ohms which means that a resistance of 25 ohms is necessary to dim out such a load. One must keep in mind that total resistance is not the only factor to be considered in the selection of a rheostat or theatrical dimmer, for the current carrying capacity is of equal importance.

Theatrical dimmers are rated in watts: for example a 1000 watt dimmer can be safely connected in series with a 1000 watt lamp or a group of lamps whose total wattage is 1000. If a

[5] The resistance of a lamp filament when cold is different from that when it is hot. We are dealing with lamps which are lighted; so we are interested in hot resistance only.

Fig. 4. Resistance Curve for Dimmers

larger load were connected to the dimmer, it would overheat, and, more than likely, burn out. A smaller load is safe, of course, but a smaller load requires a greater resistance to dim it completely out. For these reasons a dimmer should be connected to a load equal, approximately, to the rating of the dimmer. The discussion and explanation above concerning the current carrying capacity and resistance necessary for dimming has been included not only to enable the reader to understand the principles involved, but also to serve as a possible guide in the construction of home-made dimmers and in employing rheostats not intended for theatrical use. Producing groups in colleges and high schools can usually borrow rheostats from departments of physics and of electrical engineering when the rheostats are to be used for a day or two only. In such cases a calculation of maximum resistance and current carrying capacity should always be made to prevent damage to the apparatus.

CHAPTER III

ELEMENTARY PHYSICS OF LIGHT—REFLECTORS AND LENSES

1. Introduction

Light is defined by Kimball [1] as the agent which excites the sensation of sight. That is, if a light source such as an incandescent lamp is placed in front of the eye, light from the source travels in straight lines and falls upon the retina of the eye, and we say that we see the lamp. For example, when the curtain rises on a dark stage, we see absolutely nothing, but when the electrician closes a switch, and lights go on, the whole setting is revealed to us. Probably none of the light sources can be seen from the audience, but light from these sources passes in straight lines to the various objects upon the stage. From the objects the light is reflected and sent out again in straight lines to the eyes of the audience. The setting is seen because it reflects light.

Substances which transmit light freely are said to be *transparent;* those which intercept it are said to be *opaque*—either reflecting or absorbing. A substance such as frosted glass might be thought of as semi-transparent or semi-opaque. Light passes through the frosted glass but is changed in a way which does not allow objects to be seen through the glass. Such a material is called *translucent.*

All substances partly reflect and partly absorb light. Even a substance like transparent glass absorbs and reflects a part of

[1] Kimball—"A College Text Book of Physics."

the light which falls upon it. Materials are never completely absorbing, completely reflecting, or completely transmitting; so we have a method of expressing the degree of absorption, reflection, and transmission. We express the relative ability of a material to reflect light by its *coefficient of reflection* which is defined as the ratio of the reflected light to the incident light. If a substance reflected all of the light which fell upon it (none being absorbed) the coefficient of reflection would be one (1.0), but nothing has such a high reflective efficiency as that. Some white materials have a value as high as 0.95. Black velvet reflects less light than any other substance, but its coefficient of reflection is not zero but about 0.004. All other materials, including colored ones, have a coefficient of reflection falling between these two values.

2. Kinds of Reflection

When light is reflected from a flat polished surface, the reflected light appears to come not from the surface itself but from objects which seem to be behind the surface; this is called *regular reflection*. In regular reflection the angle of incidence is equal to the angle of reflection, and they lie in the same plane. This is important in stage lighting because mirror reflectors, both of glass and polished metal, are used in many lighting units. A mirror produces regular reflection.

Other kinds of reflection used in stage lighting are diffuse, spread, and specular.

Diffuse reflection spreads the light in all directions. Flat or rough white paint which is used in some footlight and borderlight reflectors and in some floodlight hoods is an example. (Ch. IV, Sects. 2, 3, & 4).

Spread reflection sends out light at the angle of incidence but spreads it somewhat. Aluminum paint and etched aluminum are examples of spread reflection. Different kinds of floodlight reflectors have spread reflecting surfaces (Ch. IV, Sect. 7.)

Specular reflection is a mixture of regular and diffuse reflection. Most of the reflected light is sent out in all directions but a part is sent out at an angle equal to the angle of incidence. The white enameled steel reflectors seen everywhere are examples, and on the stage, borderlights and footlights sometimes have such reflectors.

The important thing to understand from this discussion is that the efficiency and the usefulness of reflectors employed in lighting depends fundamentally on the nature of the surface of the material from which the reflector is constructed. One should be able to choose the right sort of surface for the effect in lighting that he is trying to achieve. The next thing to consider after the surface is the shape of the reflector.

3. Types of Reflectors

To obtain a necessary distribution of light on a surface, such as a cyclorama (Ch. IV, Sect. 5) or the stage floor, definite forms of reflectors are useful, and often the various forms are combined to get a special distribution of light. Only the two simplest and most important ones will be discussed here.

Spherical reflector. A spherical reflector of glass or polished metal, which is used in a spotlight (Ch. IV, Sect. 8), is a portion of a spherical surface. The concave side is the useful one for spotlights. When the light source is placed at the center or curvature of the mirror, the light rays are turned back on themselves to the source, and greatly increase the intensity of light leaving

the source in the opposite direction. In this way the spherical mirror increases the intensity of light from a spotlight about fifty percent.

Parabolic reflector. A parabolic reflector, made of glass or polished metal, has the form of a portion of the surface of a paraboloid (Fig. 5). If a source of light is placed at the focus of a parabolic mirror, the rays of light which strike the mirror are sent out in parallel lines. This powerful reflector, used in automobile headlights and searchlights, is common in stage lighting practice for units without lenses such as borderlights, footlights, and

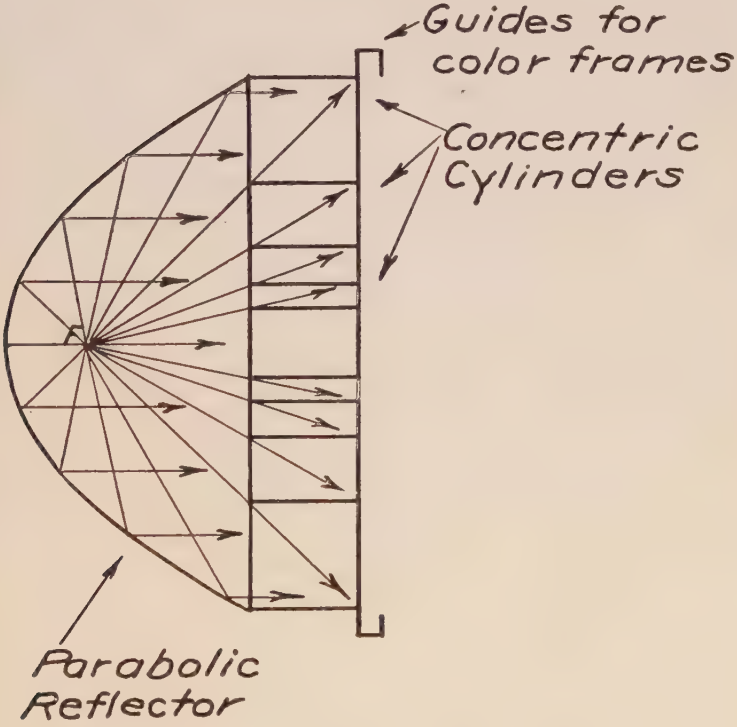


Fig. 5. Parabolic Reflector Equipped with Spill Shields

special spotlights. Lighting units for outdoor lighting are often constructed with parabolic reflectors.

4. Lenses and Prisms

When light passes from one medium to another, from air to glass for example, there is a slight change in direction if the light strikes the glass at an oblique angle. If, however, the glass has parallel sides the light leaves the glass in the same direction in which it entered. On the other hand, when the sides of a piece of glass are not parallel, the light changes direction upon entering the glass and is bent farther from its original direction upon leaving the glass. A triangular prism is an example. Bending the light in this way is called refraction.

The usefulness of a lens depends on its ability to refract light because, like a prism, its surfaces are not parallel. A lens is a piece of glass or other transparent material bounded by portions of two spherical surfaces or by a plane and a portion of a spherical surface. The plano-convex lens (one plane surface and one spherical) is used commonly in spotlights and often is called a condenser lens. The double convex lens is used in effect machines and is often called an objective lens. In both of these lenses light rays passing through the lens parallel to the axis [2] converge to a point called the principal focus (Fig. 6). The focal length is the distance from this point to the center of the lens.[3]

5. Application of Lenses to Spotlights

The diagrams, Figure 6 and Figure 7 show the relationship of reflector, lamp, lens, and surface upon which the spot of light is cast. The light source, the filament, is the object, and the spot

[2] The line joining the centers of curvature of the surfaces of a lens is the axis.
[3] This is sufficiently accurate for stage purposes.

of light is the image. The lamp receptacle is mounted on a slide which can be moved toward or away from the lens. The reflector is fastened rigidly to this slide because its highest efficiency, as was explained in Section 3, depends upon its center of curvature being at the filament. If the slide is set so that the filament is at the focus of the lens, the light will go forth in parallel lines to

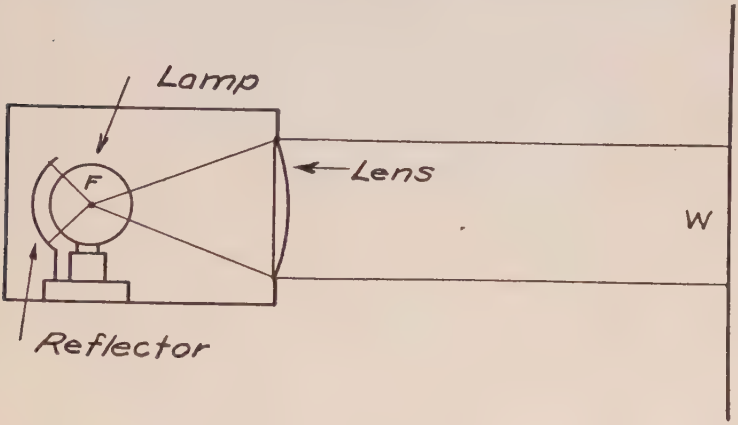


Fig. 6

form a spot of minimum diameter (Fig. 6), but an image of the filament will fall upon the wall W. This is undesirable in stage lighting; so spotlights are often made with slides which will not allow the filament to reach the focus. As the slide moves forward from the focus to the lens, the diameter of the spot of light at W increases (Fig. 7). It is necessary for highest efficiency to have correct optical alignment of lamp, reflector, and lens.

To select the most efficient spotlight for a specific purpose on the stage, to adapt a spotlight to different uses, or to buy a spotlight intelligently, one must know the nature of lenses. One really should refer to the standard texts on physics and learn to

make the calculations and use the formulas. They are omitted here to make the discussion less technical, but perhaps a few general suggestions will be helpful. In any spotlight the distance from the lens (see page 233) to the center of the filament of the lamp when the lamp is as far from the lens as possible is

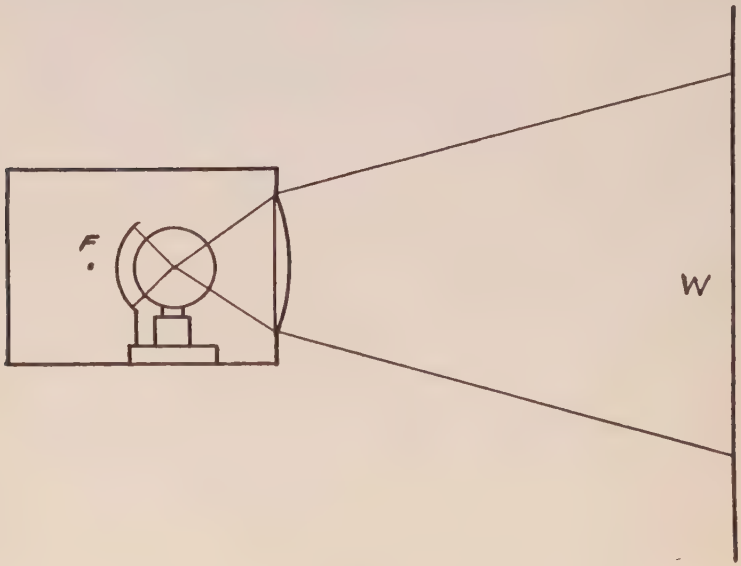


Fig. 7

fixed. To use the spotlight for a fairly long throw, a lens of focal length just slightly greater than the distance mentioned above is needed. Suppose one who is using a spotlight for a short throw wants a wider spread than this lens will produce when the lamp is pushed forward to the lens; to obtain a wider spread of illumination, he can replace this lens by one of longer focal length. This will produce a wider spread because the lamp filament will be farther forward from the focus than in the first case. Conversely, if one has a spotlight which produces a

spread of light too wide for a certain purpose, a lens of shorter focal length should be used. Accordingly, it is desirable to have two lenses for a spotlight to make it adaptable to long and short throws. A short focus lens, being thicker, absorbs more light than one of long focus, which is comparatively thin. It is evident, then, that the more one knows of optics the better able he will be to choose lighting units wisely.

6. Objective Lenses

To secure freedom from distortion and color, an objective lens usually is composed of two lenses. They are used on the stage to project an image of a slide on a surface just as the old magic lantern did. In the effect machines described in Chapter IV, Section 10, the objective lens is the front lens of a combination which also contains a slide or effect holder and a condenser lens; see Figure 8. The objective lens can be moved a short distance for focusing. This combination is placed on the front of a spotlight; then the whole optical system (shown in Figure 8) consists of the following: spherical mirror, lamp, two condenser lenses, slide holder and slide, and the objective lens. (For details of the

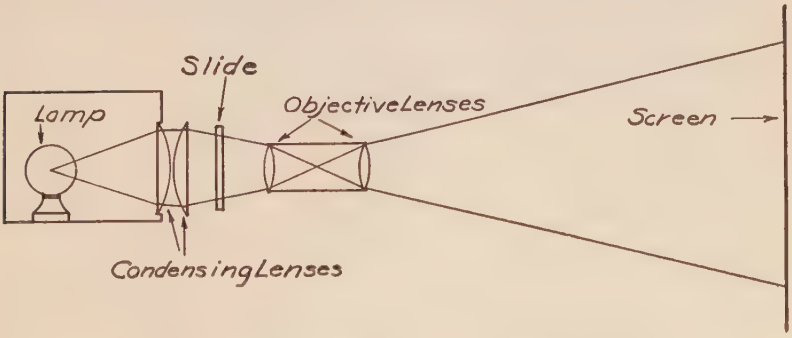


Fig. 8. The Elements of an Effect Machine.

use of this combination see Ch. IV, Sect. 10 and Ch. VI, Sect. 18.)

Obviously, one must know the size of a lens to get a certain size image at a certain distance. To calculate the dimensions accurately one uses the lens formula found in any text book on physics, but roughly, the size of the slide is to the size of the image to be projected, as the focal length of the objective lens is to the distance from the lens to the image. This is assuming that the image projected is at a considerable distance from the lens and that the slide is approximately at the focal distance from the objective lens. In general, for a long distance of projection a long focus lens should be used, and accordingly, a short focus lens for a short distance. Calculation is always preferred to estimating, however.

7. Conclusion

It is difficult even to touch the various principles of reflection, transmission, and refraction in such a short space and without being more technical because this is definitely a technical subject. It is very important, however, that one should know these principles thoroughly, and a student of lighting should refer to the standard texts on physics and do further study.

CHAPTER IV

LIGHTING APPARATUS

1. Introduction and Classification

Before one can discuss lighting design for dramatic productions, the problems of light, shade, and color, and the production of lighting effects on the stage, one must be familiar with the electrical equipment of the theatre. There are several reasons why one should be familiar with standard equipment, that is, equipment which can be purchased from the reputable manufacturers and dealers in lighting equipment. If one is connected with a college or community organization which is building a theatre, he will want to buy some of this equipment, and before he buys it he will want to know the different types and the advantages and disadvantages of each under different conditions. Furthermore, every producing group is continually replacing the old and adding new kinds of lighting apparatus because it is being improved upon every day. In addition to these reasons for being familiar with standard equipment, another good reason is that some pieces of apparatus and many accessories can be made by Little Theatre electricians if they know something of the construction of these pieces of apparatus and something of the physics of lenses and reflectors (Ch. III). The writer will feel well repaid if this information about lighting equipment saves even a few theatres in colleges, schools, and communities from the mistakes of uninformed architects and equipment

supply companies who place obsolete and inefficient lighting apparatus in a great many buildings.

For convenience in discussion, lighting apparatus will be divided into five groups: (A) apparatus for providing general illumination; (B) apparatus for providing specific illumination; (C) effect apparatus; (D) miscellaneous accessories; and (E) lighting control equipment. In group (A) are the footlights, striplights, borderlights, and floodlights; in the second (B) are the spotlights; in the third (C) the effects like sciopticians, lightning, rainbow, and others; in the fourth (D) are the cable, connectors, conductors, plugs, plugging boxes, lamps, and so forth; in the fifth (E) are the switchboards and dimmer systems. Since the tendency in lighting equipment is toward greater flexibility, the apparatus permanently placed in any one position is reduced to the minimum, more movable units are being used, and control apparatus is becoming more and more elaborate and more convenient. Few things are permanent in the modern theatre. Apparatus is designed to be rearranged and reconnected easily and quickly.

A. Apparatus for Producing General Illumination

Excepting floodlights, all of the units for general illumination—footlights, borderlights, striplights, and cyclorama lights—are very similar in essential structure and consequently in the sort of illumination which they produce. Each is a strip composed of a reflector or a series of reflectors and a row of lamps below which is a metal wiring box where all of the wires are carried. The wires connect the lamps in parallel (Ch. II, Sect. 1) like all stage lighting circuits. Such floodlights as olivettes, and any others which do not confine their illumination to a

specific small area, also fall in this class. They are not similar in form to the other unit in their class, but since the nature of their reflecting surfaces, the shape of the reflector, and the design of the unit itself do not confine either the direct or reflected illumination to a specific area, they belong in this class rather than in class B. The objections, advantages, purposes, and uses, as well as more detailed descriptions of each unit, will be found under individual headings in the following sections.

2. Footlights

The conventional type of footlights of about twenty-five years ago, which is still in use, consists of a trough reflector of sheet metal with one or two rows of clear and colored lamps placed in front of it (Fig. 9). The shape of a section of the reflector is almost anything one can imagine, including square, but parabolic is probably best for this kind of reflection. The disadvantages of

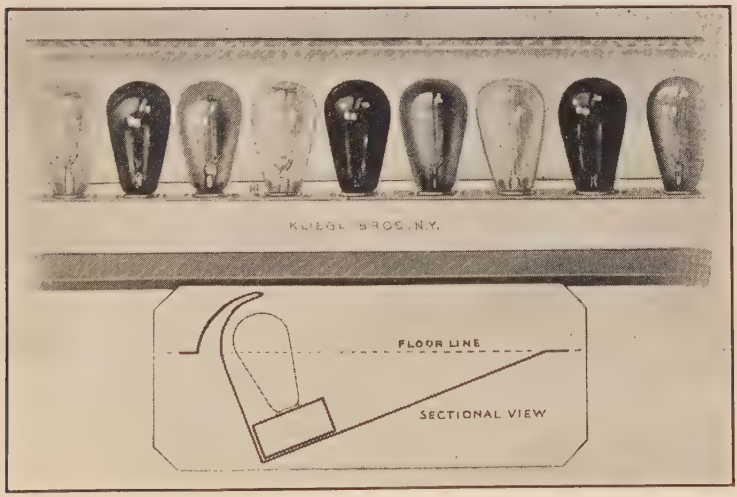


Fig. 9. Footlights with Trough Reflector

this old type of footlight unit lies in its inefficient reflection, in its improper distribution, and in the passage of light of one color through adjacent lamps of another color. A newer and better type is provided with individual parabolic (Ch. III, Sect. 2) reflectors of rippled mirrored glass or semi-matte surfaced metal (spread reflection Ch. III, Sect. 2) for each lamp in a separate compartment with individual color screens of glass or gelatine (Fig. 10).

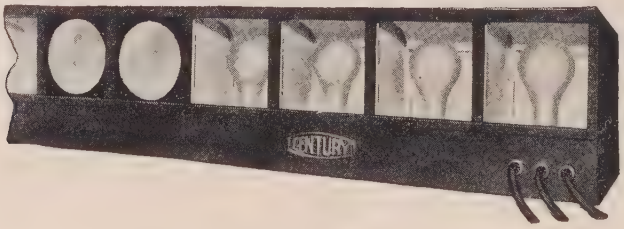


Fig. 10. A Compartment Striplight

The latest design in footlights, with several advantages over other types, consists of a wiring box of sheet metal with one or two rows of receptacles on one face and a number of units which are plugged into these receptacles;[1] the unit is a cylindrical neck which is enlarged at one end into a reflector which is fitted with a glass roundel similar to railways signal lenses. The unit is made in sizes to contain certain standard sizes of lamps. There are, apparently, several advantages in this type. The units can be plugged in and out quickly to distribute the light in different places, and spotlights can be plugged into the vacant receptacles (Fig. 11). The glass roundels can be obtained in the necessary colors which are permanent, and, since the glass is heavy, with reasonable care it is almost unbreakable. Furthermore, the

[1] Manufacturers differ in their construction of this type of footlight unit. Those in Fig. 11 cannot be plugged in and out.

roundel fits snugly into the mouth of the reflector, thus preventing dust from accumulating on the lamp and reflector. The intensity of light from these units is from two to four times that of the old type. Another type of footlights occasionally seen is an indirect one. In this the unit is entirely below the stage and throws the light upon a white painted reflector placed in the

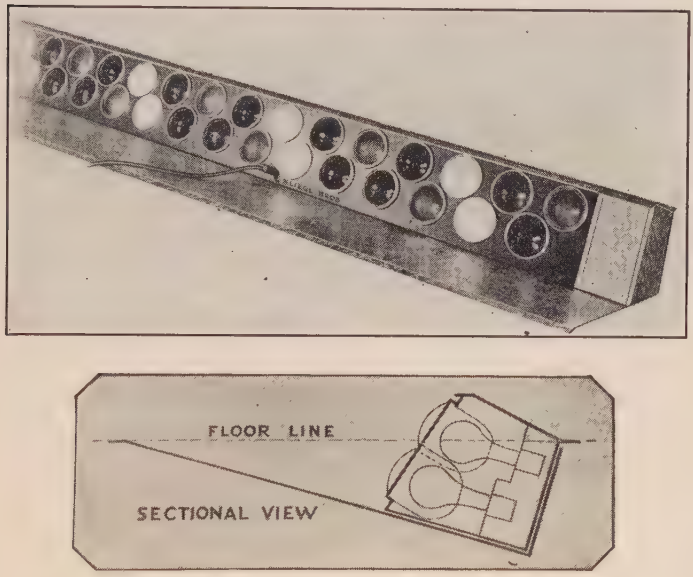


Fig. 11. New Type of Footlights

usual position of the footlights. These are usually arranged, so that the angle of the light unit and the angle of the reflector can be adjusted. In this indirect type the color of the mixture is effected on the reflector and a soft diffuse light comfortable for the actor's eyes is the result of the indirect lighting. The footlights in the new University Theatre at Yale are designed so that they can be used either as indirect or direct.

Footlights more often produce too much rather than too little light, and, when they are not controlled by dimmers, too much is worse than too little. Lamps for footlights should range from 25 watts to 75 watts with possibly 100 watts as the maximum. Footlights containing 200 watt lamps are, however, occasionally seen. They are sometimes wired in three groups so that one-third or two-thirds of the length can be lighted without the other. Whether this is practicable or not, certainly the whole length should be wired in four circuits for blue, green, red, and clear lamps. The reason for the choice of colors and the necessity for four circuits is explained in the chapter on color (Ch. VII).

The footlight unit should be placed on the stage so that the top of it is not more than 3½″ above the floor level. The horizontal spread of illumination should be such that color mixture takes place within two or three feet, and the vertical spread should be about 75 degrees. The light should never spill on the sides or on top of the proscenium arch, and the intensity should always be kept low. Like colors should not be more than 20″ apart, preferably less.

While footlights fall more naturally into group one than any other, they should not be used to produce more than a small part of the general illumination of a setting. If the intensity of illumination from footlights is high enough to be a major part of this general illumination, the features of the actors will have a grotesque and distorted appearance and a multiplicity of abnormal and undesirable shadows will be cast upon the scenery and properties. The cure for these undesirable shadows is simple; merely reduce the intensity until they disappear. The useful purpose of footlights is to lighten and soften the shadows in the actors' faces when they are playing far down-stage. Foot-

lights are improperly employed if they are used to aid the audience in seeing the expression on the actors' faces when they have come so far down-stage that they are entirely out of range of the other lighting units behind the proscenium. This applies particularly to non-professional productions, because the inexperienced player with a slight, untrained and undeveloped voice must play as near the audience as possible, so that his voice will not be lost in the flies.

Theatres properly designed and constructed will have hiding places in the ceiling, walls, or front of the balcony in the auditorium where spotlights can be concealed. Using spotlights placed in false beams or some other hiding place in the ceiling about 15 to 30 feet from the proscenium is the best way of removing the burden from the footlights. This source of light in front of the prescenium will illuminate the actors from a overhead natural angle when they are playing far down-stage near the curtain line and will throw the shadows down upon the floor and not upon the scenery as footlights of high intensity do. Footlights of low intensity used with the overhead illumination in front of the proscenium serve their purpose of producing a gentle glow of general illumination which will soften facial shadows. Many plays are produced without the use of footlights because certain conditions of production make them unnecessary. Mr. Fritz Leiber, the well known Shakespearian actor, uses no footlights for tragedy because he plays it well up-stage, but in comedy, which he plays down-stage, he always uses footlights. The Guild Theater in New York has footlights, but they are used only for lighting the front curtain when it is down. It is well for theatres to have footlights, but every production does not require them. Footlights have a legitimate use, but more often than not, they are misused.

3. Borderlights

In construction borderlights might be said to be footlights hanging overhead. The old style of borderlight unit, although still seen in many theatres, is open to the same criticism as the old footlight unit; low efficiency, improper distribution of light, and undesirable mixing of colors. The new type of borderlight,

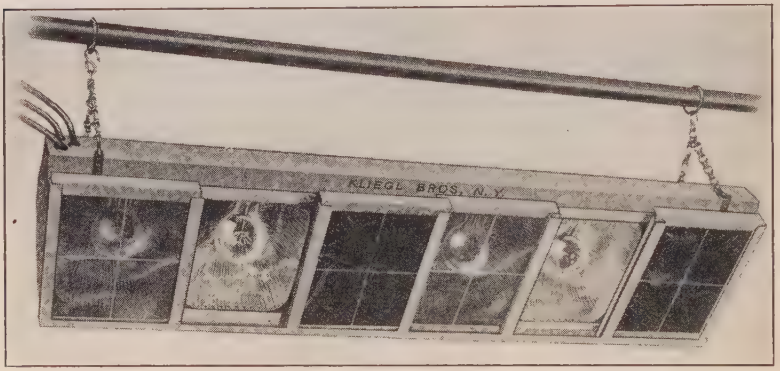


Fig. 12. Compartment Borderlight

the compartment type, is similar to the new footlights with individual reflectors and color screens (Fig. 12). Compartment borderlights ordinarily contain larger lamps than footlights; they vary from 75 watts to 500 watts, but Little Theatres rarely need them as large as 100 watts.

There is another borderlight unit similar to the footlights called above "the latest design" (Sect. 2). This type with the removable unit has all of the advantages mentioned in footlights. The remarks about number of circuits, color screen, and so forth for footlights apply equally well to borderlights. Borderlights are often provided with guards to prevent drops, which are being moved, from pulling off the color screens and to prevent pieces of the screens and broken lamps from falling and strik-

ing workers below. Borderlights are usually hung from pipe battens by short chains, which permit the borderlight to be twisted about its own axis to change the direction of light. The new compartment border directs and restricts the light more narrowly than the old by reflectors whose lower portion is parabolic and whose upper portion is spherical. Mirror reflectors are probably better than diffuse or spread reflecting surfaces (Ch. III, Sect. 2) for directing the light to certain areas. At times one wants the light almost directly down, and at others one may want the light thrown back.

The older theatres were furnished with three to ten or twelve borderlights hung at regular intervals from the proscenium to the back wall; the number, of course, depending on the depth of the stage. The modern theatre that is producing plays artistically lighted uses only one or perhaps no borderlights at all. The Guild Theater in New York uses no standard borderlights. A borderlight placed just behind the proscenium is, however, often useful. If a box set (an interior) with a ceiling piece is being used, the first or concert border is one of the few useful pieces of apparatus for producing general illumination because there is very little space for hanging lighting units. Further discussion of this problem will be found in Chapter VIII.

4. Striplights

At one time striplights, similar in design to borderlights and footlights, were fastened vertically to each side of the proscenium and just out of sight of the audience. They were called proscenium strips. When an exterior scene was in place, a similar strip was fastened vertically behind each wing of the row of wings which usually masked the boundaries of the playing area.

Most modern theatres, however, have relegated the permanently attached proscenium strip to the museum. A few theatres, on the other hand, have retained them in position to light the front curtain when it is down, but there are more effective and more efficient ways of doing this, too, than by means of proscenium striplights. Certainly for the lighting of a scene, either interior or exterior, the proscenium strip is entirely out of range when tormentors and inner-proscenium frames are in use (Part One, Ch. II, Sect. 2).

A short portable strip of the compartment type varying in length from one to ten compartments is a very useful piece of apparatus. To give the effect of illumination in a hall or room, a part of which is visible through a door-way leading off-stage, a short strip of one or two compartments can be hung behind and above the door way. Sometimes short strips five or six feet long are attached to standards which roll on casters. These are sometimes set in various places to give additional general illumination from the side. Short strips are placed on the floor behind ground rows or properties to illuminate another ground row farther upstage, to kill undesirable shadows, or to increase the general illumination. Occasionally they are used for cyclorama lights.

5. Cyclorama Lights

A sky cyclorama extending across the back and well down the sides of the stage is almost indispensable to every theatre large or small. A fairly good substitute on a very small stage is the sky drop (Ch. II, Sect. 13). A small cyclorama, however, which hangs from a traveller and can be run around to a side when not in use, has the advantage of enclosing the sides as well

as the back of the stage. Even the simplest and cheapest painted cotton material properly lighted will produce to a degree, the illusion of sky. The plaster dome, a solid structure at the rear of the stage, curving forward at the sides and at the top, was hailed a few years ago as a perfect sky producing the illusion of great distance, but now the A. R. S. cyclorama and the Hasait cyclorama are thought to be better because they can be moved out of the way if necessary when not in use. These cycloramas are attached to a roller at one side of the stage and are run out on a track when needed. Needless to say, they are very expensive. The common type of cyclorama constructed of canvas or muslin and dyed or painted a tint or shade of blue is very satisfactory, however, and it will be found in many of the best modern theatres. The cloth should be fastened to a pipe batten at the top and at the bottom, and stretched tightly, so that no wrinkles will appear (Part One, Ch. V., Sect. 12).

Lighting a cyclorama is not a difficult problem if one has a sufficient number of properly designed units to secure an even distribution from side to side and from top to bottom. This lighting can be approximated (rather crudely perhaps) by having a row of olivettes or floods, containing 500 or 1,000 watt lamps, around the top of the cyclorama and a similar row of olivettes (Fig. 13 and Sect. 6) or strips around the bottom on the floor if the cyclorama is small. Appropriate color screens must be provided to produce night and daylight skies, sunsets, and sunrises.

A better but a more expensive way of lighting the cyclorama is with units especially designed for cyclorama lighting. They are like borderlights and footlights with narrow compartments, so that color mixture is effected near the unit itself. The lamps used are 200 watt to 1000 watt. The units lighting the

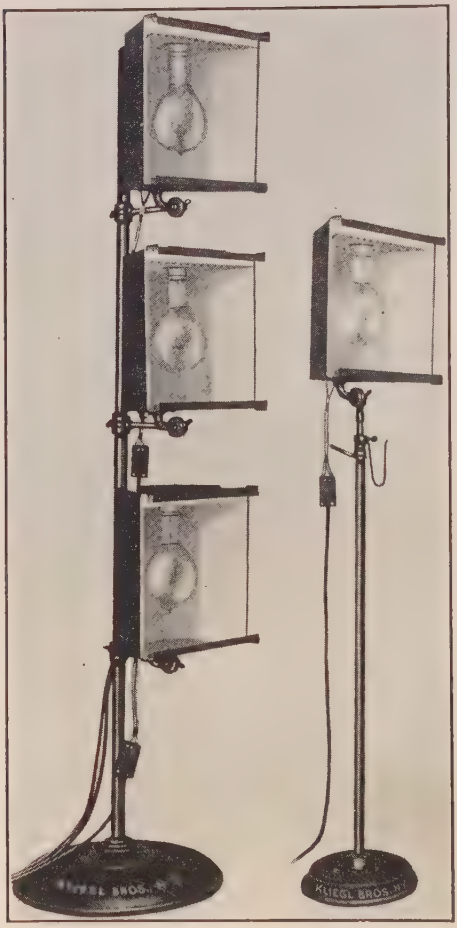


Fig. 13. Olivettes or Floodlights

cyclorama from the top are hung from pipe battens like border lights, whereas the cyclorama footlights are usually recessed in the floor and covered with heavy glass which can be walked upon. Sometimes large cyclorama footlights, mounted on roll-

ers, are placed in front of the cyclorama for lighting from below. These, unfortunately, require some sort of mask to hide them from the audience.

The method of lighting used in Germany, and occasionally in the United States, is to have a large battery of cyclorama lighting units (designed for a certain distribution of light) mounted on a frame which is hung at a considerable distance down stage from the cyclorama. Footlight strips for the cyclorama are often used at the same time. It is thought that this method produces a more uniform distribution of light than the method described above.

6. Floodlights

A floodlight might be described as a double-walled sheet-metal box without a lid but with light-tight ventilators in the walls and with guides in front to hold a color screen. The stand type illustrated in Figure 13 has a telescopic stand for raising and lowering the hood, and a swing joint for changing the angle of illumination. Figure 13, the more common of the floodlights (made by all manufacturers) has a reflecting surface of flat white paint; similar floodlights but with more efficient reflectors both in shape and surface are available from Kliegl, Display, Holzmueller and Major. This stand type fitted with either a 500 or 1,000-watt lamp (P. S. form) is a very useful piece of apparatus for theatres of any size. Workers in Community and Little Theatres will find many uses for two or three floodlights on stands. For illumination of high intensity over fairly large areas, for lighting off-stage backings, for light going through windows in interiors, and for coloring neutral draperies such as monk's cloth, these floods (sometimes called oli-

vettes) are effective. The suspension type is hung from pipe battens by chains or pipe clamps. This type is very useful in groups for the lighting of sky-drops and cycloramas, for overhead general illumination in place of borders, and for coloring draperies from above. A number of these should be a part of the lighting equipment of every theatre. Olivettes or floodlights, like all movable equipment, are plugged into floor pockets or wall pockets.

B. Apparatus for Producing Specific Illumination

7. Introduction

The apparatus for producing specific illumination consists of spotlights of many kinds. There will be no attempt to describe or discuss every type of spotlight which can be purchased today, but the purpose of this section is to familiarize the reader with the general field of apparatus and to point out the advantages of a few units which are most useful to the small nonprofessional theatre group. Such a group is interested in a few units which can be adapted to all of their lighting problems, and some of these units are not at all impossible to construct if there are ingenious mechanics and electricians at hand who know their optical and electrical principles. Building these units is not as easy, however, as some authors of books on play production would have the novice believe. To throw a receptacle and lamp into a stove pipe to make a spotlight reads easily enough, but to make a spotlight with a lens, reflector, focusing device, properly ventilated lamp house which will not spill light, and clamp for hanging—that is, to make a really useful piece of apparatus, is an entirely different matter. One might better buy a few conventional spotlights, for sale by all of the reputable

dealers, and use his ingenuity on adapting and improving them after he has learned their limitations through experience. One warning in buying equipment might be worth while. If one is not familiar with the equipment of half a dozen dealers, he will spend twenty-five dollars for a baby spot, although one which is very similar and just as useful and durable can be bought for fifteen dollars. On the other hand one must be very certain that the cheaper article has all of the necessary features to serve the purpose intended.

8. Spot-Floods

"X-Ray" (polished ribbed metal or ribbed glass mirror) or similar reflectors (Fig. 12) are made into units or used independently as a sort of combination flood- and spotlight. The design of these reflectors approaches parabolic and, accordingly, directs or tends to direct the light into straight lines without the use of a lens. It is not difficult to equip the reflector wih a lamp socket and guides for color screens. For a short throw this unit is very useful to give diffused illumination confined to a smaller area than that of an ordinary floodlight. A useful lighting unit which produces a spot of concentrated illumination for both long and short throws can be made in the following manner. A parabolic reflector of any desired size is fitted with concentric rings about 3 inches wide and placed as in Figure 5. The reflector sends forth the reflected light in approximately straight lines, and the concentric rings confine the direct light from the lamp to straight lines thus producing a concentrated area of light without the use of a lens. Major Equipment Company and others offer these for sale (see list of dealers in appendix). This unit can be used effectively to produce the illusion of sun-

light. It is highly efficient, but it has the disadvantage of being rather large. It can be made to focus somewhat, though it does not have the range of focus common in a lens spotlight described and discussed below (see Fig. 13A).

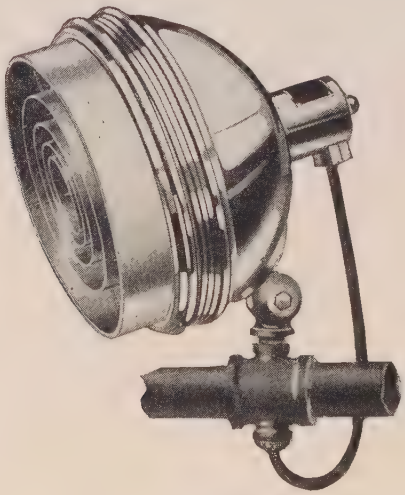


Fig. 13A. A Spot-Flood with Concentric Spill Rings

9. Spotlights

A spotlight consists of a heavy sheet-metal lamp house which is properly ventilated and light proof (it should not spill light through the ventilator or focusing slot). The size of the lamp house depends on the size and intensity of the light source to be placed within and somewhat upon the focal length of the lens (Ch. III). In any case there must be sufficient space around the lamp for free circulation of air, and there must be sufficient length from lens to back to allow proper focusing. A lens is

placed in a circular opening in the front of the lamp house, and within is a receptacle for the lamp mounted on a moveable slide. If a reflector is provided, it is attached to the slide (see Chapter III, Section 5 and Figure 6 for relationship of lens, reflector, and lamp). The medium and large size spotlights contain a mogul receptacle for 500 to 1000-watt G shape lamps,

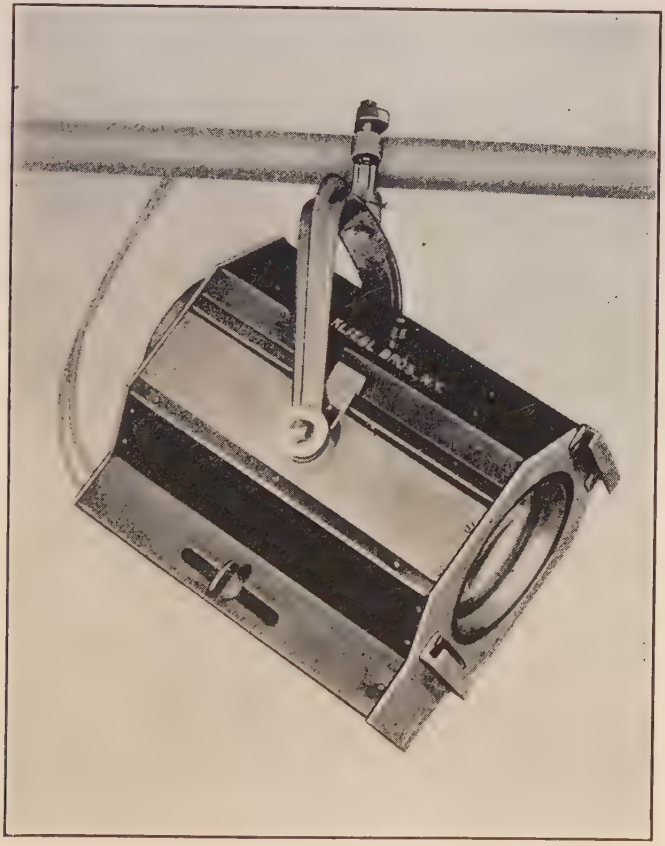


FIG. 14A. 500 TO 1000-WATT SPOTLIGHT SUSPENDED BY YOKE AND CLAMP

and the baby spots have the medium receptacle for 250-watt and 400-watt G shape lamps. Only concentrated filament (G shape) lamps can be used in spotlights (Sect. 17).

Nearly all spotlights can be purchased either with stands, with

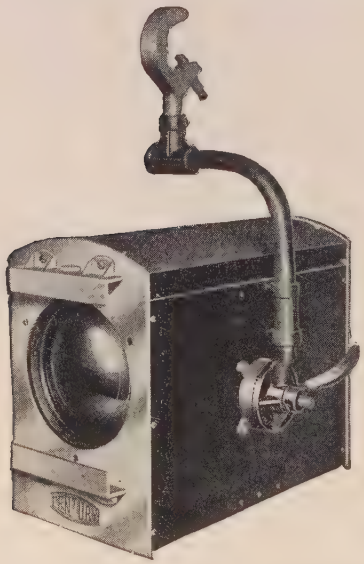


FIG. 14B. CENTURY 1000-WATT SPOTLIGHT

With off-set suspension arm which overcomes the difficulty of the eccentric load on the usual straight arm.

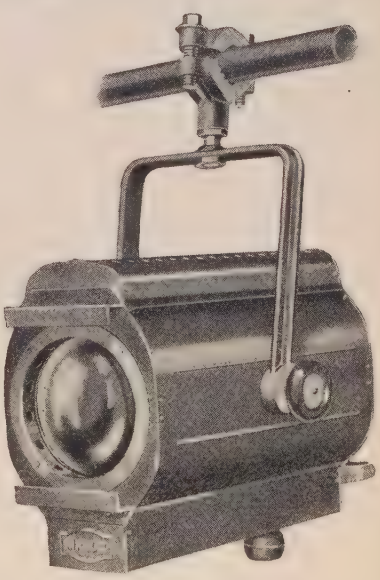


FIG. 14C. 1000-WATT SPOTLIGHT OF SLIGHTLY DIFFERENT DESIGN WITH YOKE AND PIPE CLAMP

yokes and pipe clamps, or with suspension arms and pipe clamps (Figs. 14–15, 19 & 20). Many spotlights are designed to be used interchangeably with either suspension arm or stand or are designed to be used with either yoke and pipe clamp or yoke and stand.

The writer has found that a spotlight for suspension is better

with a yoke than that with a suspension arm. Because the yoke is attached to both sides of the spotlight, the weight is properly balanced. Since the suspension arm is attached to only one side and the heavy weight of the spotlight is at a considerable dis-

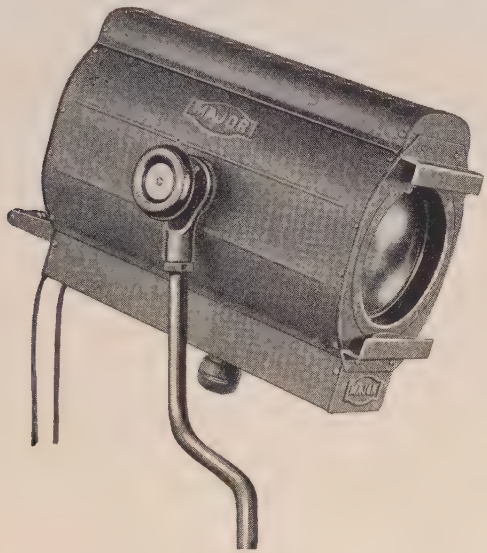


Fig. 15A. 1000–1500 Watt Spotlight
One of the best in design and construction.
Shown attached to stand.

tance from the pipe clamp, the weight of the spotlight tends to twist or overturn the object to which it is attached, such as pipes too large or too small for the pipe clamp, a wooden batten, or other sections too large or improperly shaped for the clamp. In these cases the suspension arm, if it could be attached at all, could not be attached rigidly in order to direct the light where it is wanted. Kliegl, Major, and Holzmueller have desirable spotlights with yokes. Although one or two 500–1000 watt spotlights are useful for a long throw, such as lighting down-stage with spots from the ceiling of the auditorium, the baby spot

Fig. 15B. Century 1000-Watt Spotlight on Stand

(250–400 watt lamps G shape) is adaptable to a greater number of uses than any other single unit in a small theatre (Figs. 16–17). For a short throw from a pipe batten overhead, the baby spot is very useful in increasing the intensity over particular areas of the stage. The baby spot is so small that it can easily be concealed in the footlight unit, in ornaments, or behind properties to attract attention to a grouping, an individual, or a

significant object. The front of many baby spots can be removed to produce small floodlights. In groups of six mounted in a yoke they are used as a focusing borderlight.

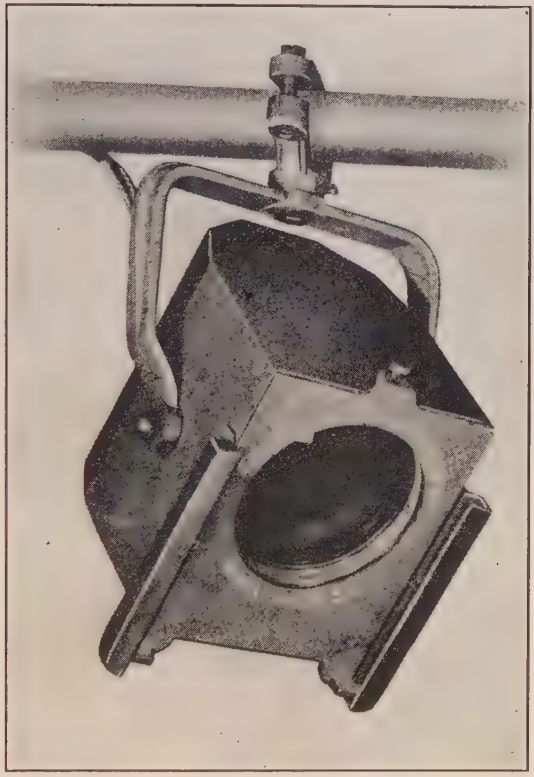


Fig. 16. Baby Spotlight with Removable Front to Use as a Small Floodlight. One of the Best

One should look carefully at the product of a manufacturer who is offering a unit much cheaper than his competitors. The purchaser should see that the spotlight can be focused and that it has a reflector. A fixed focus greatly reduces the usefulness

of a spotlight, but a reflector adds 50 percent more light. On the other hand a cast aluminum housing, which costs more, has little or no advantage over a strong sheet-metal lamp house.

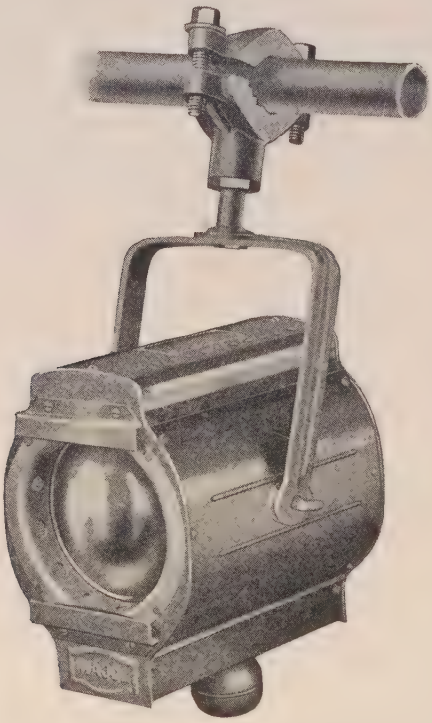


Fig. 17. One of the Best Baby Spotlights

Shown with yoke and pipe clamp.

As the incandescent lamp has improved in design and increased in size, the arc spotlight has gradually gone out of use except where very long throws and very high intensity are necessary. For outdoor performances and for projecting light from the rear of very large auditoriums the arc spotlight is still

useful. The hissing noise of the arc run on alternating current (see Ch. II) is objectionable at close range, and in any case its constant need of attention makes it undesirable. The 2000 watt concentrated filament incandescent lamp, however, is sufficiently powerful for all purposes in theatres of medium size; in small theatres its intensity is too high except in rare cases.

Spotlights were first used to draw the attention of the audience to a certain actor and to follow him about the stage. We have since learned that this unnatural effect is not a part of good lighting, but that "spots" have a much more valuable work to perform in giving variations in intensity to a scene, in directing attention, and in casting natural shadows. Furthermore, the light from the spots reveals the third dimension of the actor by giving him true form and shape; likewise, the spotlight gives depth and space to the scene in general and definition and shape to specific objects and scenery. With its concentrated beam giving masses of light and shadow where they are desired, the spotlight is the most important single unit of lighting apparatus (Chs. VI and VIII).

C. Effects

10. Sciopticons

Nearly all moving effects such as moving clouds, rippling water, rain, snow, flying birds, ethereal figures, and hundreds of others are produced with a projection machine called a sciopticon. A sciopticon is a 1,000-watt spotlight to which has been added another condensing lens, the moving effect, and an objective lens (Fig. 18 and Ch. III, Sect. 6). The moving effect consists of a mica disc or discs enclosed in a metal case to the outside of which is attached an electric motor or clock mechan-

ism for turning the disc. On the disc the effects are painted in color. The realistic and naturalistic moving effects seen in operas, prologues in moving picture houses, elaborate window displays, and in plays of the more spectacular variety, are produced by a sciopticon. The sciopticon can be placed in a projection room at the rear of the auditorium to project the effect on a drop on the stage a considerable distance away (this position is rarely used), or it may be placed on the stage at one side to project the effect a short distance. On the other hand, a translucent drop can be used with the sciopticon placed behind the drop. This procedure is usually better because it leaves the whole stage free for actors to move about without walking

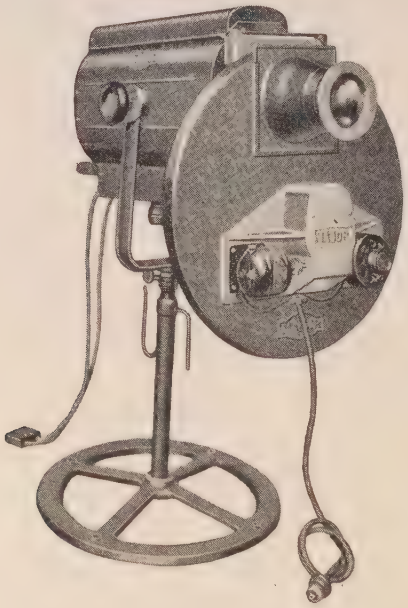


Fig. 18. Sciopticon or Effect Machine Equipped with Motor Instead of Clock Mechanism

between the sciopticon and the surface upon which the effect is projected.

Still effects can be projected with the same system of lenses as that in a sciopticon. If a slide holder takes the place of the moving effect, the resulting piece of apparatus can be attached to the front of a spotlight to make a still effect machine similar to a stereopticon. Any kind of slide can be used and projected upon a screen as explained in the above paragraph. Furthermore all sorts of shadows for decorative and emotional effects can be projected from silhouettes cut in a piece of cardboard and placed in the slide position in the effect machine. By moving the slide the shadow images can be made to move on the drop or other surface of projection if only slight movement is desired. Both in this case and in the case of the Linnebach Projector, difficulty will be found in placing the projector in a position in which there will be no distortion of the image of the slide. To correct this one can distort, in the opposite direction, the shape of the material on the slide to be used for the effect. Figure 46 is an example of a projected effect. Chapter III, Section 6 shows the relationship of the lenses, and states the method of finding the relative size of the slide and the image projected. Here is another instance of the necessity of knowing something about the behavior of light and the fundamentals of lenses.

11. Linnebach Projectors

A scene projector called a Linnebach Projector (evidently after the German theatre engineer by that name) is not difficult to construct. It consists of a large sheet-metal hood with guides for a slide. The inside surface is painted black. Within the hood is an arc or an incandescent lamp of high intensity; the whole is

mounted on some sort of stand. The slide to be used in this projector can be of glass, gelatine, or card board, and the effect to be projected can be painted or cut into the slide. This piece of apparatus is set up at the back of the stage, and the scene is projected on a translucent drop which makes the scene visible from the front. By this arrangement the actors have complete freedom of movement on the stage without getting between the projectors and the screen. By using two projectors, each with a dimmer, one picture or scene can be made to dissolve into another for supernatural or impressionistic effects. It has been used also to show first the scene in objects as they are, which later dissolves gradually into the distorted impression of this scene in the mind of one of the characters in the play. Such a method of scene projection requires a low degree of general illumination on the stage.

12. Lightning, Rainbows, and Wind

Lightning can be made with an opaque slide with a zigzag shape cut out and projected as described in Section 1. Stars can be projected on the cyclorama with an opaque slide containing a number of very small holes. Rainbow slides are often painted, but the effect produced is rarely convincing or beautiful. A better rainbow can be produced by an apparatus consisting of a lens, a curved slot, and two large glass prisms. This rainbow effect can be rented or purchased, but anyone familiar with the physics of light can assemble one for temporary use from parts found in almost any department of physics in a college or university. Lightning is also produced by an instantaneous contact between a carbon and a metal terminal. Of course, the lightning effects which are offered for sale are properly enclosed to guard

against fire. One kind is operated by hand, and another is operated by a magnet, so that it can be controlled from a distance. The wind machine, which was once a paddle wheel moving against a piece of silk, is now a motor driven siren.

13. The Moon

The moon was once a popular stage effect and even now returns to plague and distract us from more important things—the acting and the play. It is really quite fascinating, though, to see it rise haltingly from behind some gaudy ground row and soar far up into the flies on wings of fine steel wires controlled indifferently by a sleepy stage hand. The moon itself is a black cylinder with a frosted glass front. Within is an amber gelatine and a lamp of about 100 watts. It is safer and far more artistic to suggest moonlight by steel blue or blue-green shafts of light streaming across the stage from a spot or two hung high up on a tall tormentor or on the fly floor rail. It is far better to set out to have a beautiful light that will give the impression of moonlight than to set out to have moonlight and achieve only a lighted box.

14. Fireplaces

Fireplaces are quite common in interiors on the stage, and the lighting in the fireplace can be used effectively as part of the general design or plan for the lighting of the whole set. First, we must have some sort of fire. Logs are constructed from cardboard cylinders with a few slots cut in the surface. The slots are covered with red and amber colored paper or gelatine, so that some light will shine through from a 25 watt lamp placed within the cylinder. The cylinder is now ready to be decorated

with plastic clay and paint to resemble a fire log. About three or four are necessary for the fire place. A coal grate is even simpler. On the bottom of the usual fireplace grate a light circuit with several lamps is placed; on top of them rests a mixture of red, amber, and black chunks of glass. The illumination in either the grate or the logs will be only a dull glow and has nothing to do with the fireplace lighting which is to be a part of the general plan (Ch. VIII). The fireplace, unless it is in the upstage wall in full view of the audience, is a good place to conceal a small spot or flood to produce specific illumination for small objects or areas. One must take care, however, to be sure that this low position will not cast large disagreeable shadows. Important business may take place on a couch in front of the fireplace. In this case a small flood will illuminate this group with a red glow. Sometimes one wants to illuminate the face of an actor while the remainder of the scene is entirely dark. A masked spot in the fireplace could do this. In another scene a dull red light from the fireplace might effectively color a shadow while some other source is producing a high light.

15. Conclusion

One could multiply examples of electrical or electrical-mechanical effects, but, when confronted with such a problem, one usually discovers the appropriate device which is peculiarly adapted to one's stage and financial limitations. The fun of devising and constructing effects is far greater than actually using them in performance. Sunset, dawn, moonlight, fire, and hundreds of others can be produced either simply or elaborately depending on what one has to work with. Many beautiful things can be done, however, with the simplest equipment.

D. Miscellaneous Equipment

16. Introduction

As we have said in discussing other units of apparatus, we do not intend to cover every possible device which is used on the stage to connect apparatus and to supplement it. Only those miscellaneous pieces will be described and discussed which seem most useful or indispensable to non-professionals and Little Theatres.

17. Lamps

An incandescent lamp consists of a base (the part which screws into the socket or receptacle which is made in four sizes, mogul, medium, candelabra, and miniature), a bulb, or jacket, of glass, the lead-in wires, and the filament. For flood lights and general illumination lamps with pear-shaped (P.S.) bulbs are used, and for spotlight lamps with globular (G) shape bulbs are used. The general public frequently calls a lamp a bulb. This is incorrect. A bulb is part of a lamp. The G shape lamps of 250 watts and 400 watts have a medium base; larger ones have a mogul base. In the P.S. shape, lamp sizes up to and including 200-watts have a medium base and sizes larger have mogul base. P.S. lamps of 1000-watts or less can be burned in any position, but G lamps cannot be burned within 45° of vertically base up. Operators must be careful in the operation of spotlights to see that the lamps are burning in the proper position because G lamps will burn out quickly if placed vertically base up. P.S. lamps have an average life of one thousand hours, while G lamps are limited to about two hundred hours.

18. Color Frames and Color Wheels

Color frames are any sort of metal, wood, or cardboard frame used to support a gelatine medium when placed in front of a lighting unit. The frames for the large floods or olivettes are made either of wood or metal about twenty inches square. Each frame consists of two indentical parts, or halves, with several fine wires stretched across to help support the large sheets of gelatine. The gelatine is placed between the two halves, and they are held together by screws or metal clips. Clips are better because a new gelatine, if tightly confined by screws, will split when first placed in front of a hot lamp. Other frames for different sizes of floods are made in the same way and can be made easily by non-professionals. Spotlight color frames need no wires and they can be made easily from cardboard or sheet metal. They are held together by paper clips or friction tape. Illustrations of color frames and color wheels can be seen in any stage lighting catalogue.

Color wheels are circular discs of light sheet metal about 20 inches in diameter. Five or six holes the size of a spotlight lens are cut in each identical half of the color wheel and gelatine of different colors is placed between the halves and over the holes. Little bolts or clips hold the two parts of the color wheel together, and the wheel turns on a slide made to fit the guides of a spotlight. Color wheels are used with spotlights for singers, dancers, and vaudeville performers when it is desirable to change the color of light quickly.

19. Masks, Spill-Shields, and Funnels

A mask is any sort of cardboard or sheet metal slide to be placed in the guides of a spotlight to restrict the light to various

shapes. Masks may be of a single piece which has a light opening that cannot be changed, or they may be of two or more pieces, so that an operator may change the size and shape of the light opening. One which cannot be home-made and which costs about fifteen dollars from dealers is an iris diaphragm. This mask is similar to the iris diaphragm behind a camera lens and is capable of being completely opened and closed keeping a circular spot of light during the operation. One that will decrease or increase the size of the spot of light satisfactorily can be constructed with only the slightest cost, but the opening will be square, not round. It can be made from two pieces of material which will slide easily between the guides of the spot. In an end of each a ninety degree notch is cut. Any desired sort of mask can readily be cut from the cardboard to create a certain shape of lighted area. Figures 19 and 20 show tormentor spotlights equipped with framing masks and moveable spill-shields or flippers. These are built by Pevear. Non-professional electricians will enjoy constructing all sorts of accessories to place on the front of spotlights and floodlights to restrict the light to definite shapes and forms. The concentric rings mentioned in Section 8 of this Chapter are a good example.

A funnel is a cylinder of cardboard or thin sheet metal fastened perpendicularly to a square of the same material. The cylinder has no ends, and the square has a hole in it equal in diameter to the cylinder. The square part slides into the guides of a spotlight, and the funnel restricts the light and prevents spill when the spotlight is at considerable distance from the area illuminated. Spotlights in the ceiling of the auditorium nearly always need funnels or masks to prevent spill-light on the proscenium.

A funnel or spill-shield is also useful on a borderlight to

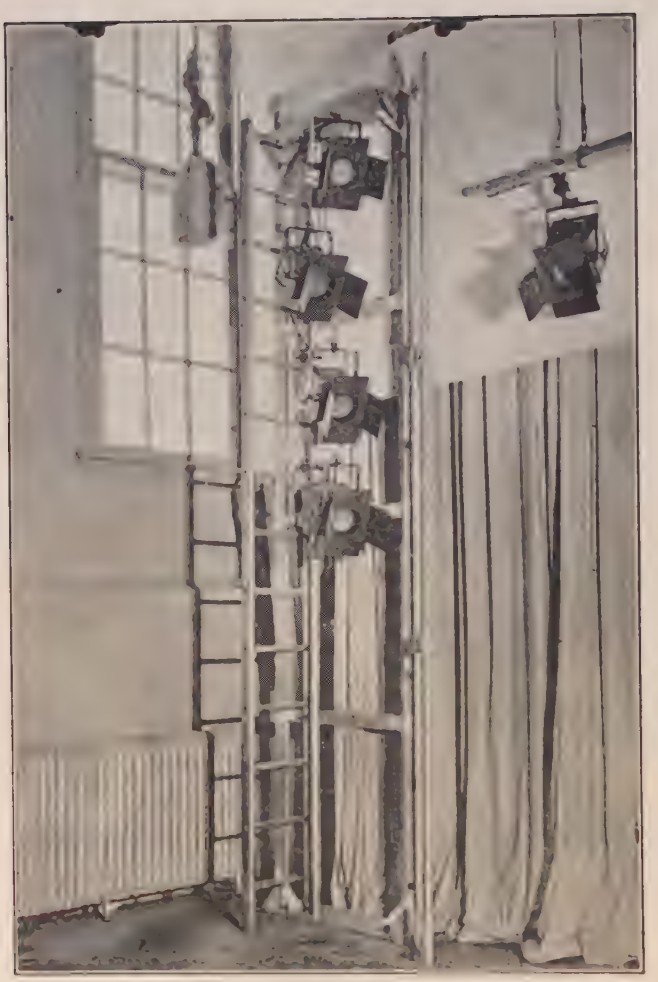


FIG. 19. A CORNER OF THE STAGE IN THE PLAYMAKERS THEATRE, UNIVERSITY OF NORTH CAROLINA

Showing Tormentor Hoods (spotlights) mounted on Tormentor batten.

restrict illumination to the floor or lower part of the walls of a set. It is a sheet metal hood or bonnet hung on the front of the border light to catch spill-light. Its shape depends on the design of the border light. Any sheet-metal shop can make one of these funnels or any of the others mentioned in this section.

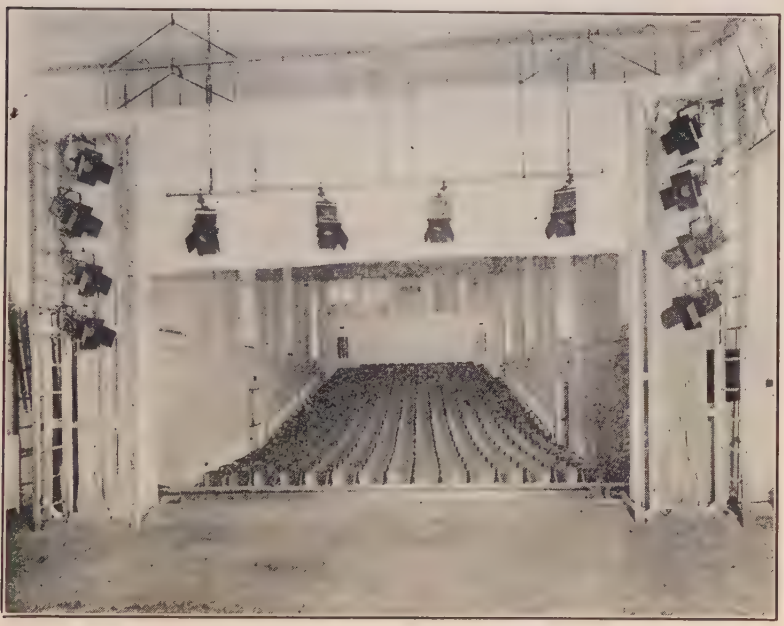


FIG. 20. PLAYMAKERS THEATRE

Showing method of hanging spotlights on border batten and tormentor battens.

20. SOFT-EDGE DEVICES

The sharp dividing line around the circumference of the area of light from a spotlight is unartistic and distracting if it falls upon scenery, properties, or actors. To eliminate this sharp line of contrast so-called "soft-edge devices" have been designed.

These devices produce an area of light, without the usual sharp line of contrast at the circumference but with no great loss of intensity at the center of the beam. One manufacturer (Pevear) sells a soft-edge spotlight (Fig. 19) which produces a soft-edge light in this manner. By placing a square of ground (frosted) glass, held by a bracket, between the lamp and the lens the light is diffused before it passes through the lens. This produces the desired soft-edge effect but with a considerable loss of light. If this piece of ground glass is oiled in the center, the center of the area of light is made more intense. This helps, but the oil would be evaporated in a few minutes inside a spotlight. Another method of producing a soft-edge is to place a piece of frosted gelatine in front of the lens. Placing frosted material in a color frame which is in the guides on the front of the spotlight produces diffusion too far in front of the lens, and the area of light is enlarged to floodlight dimensions. If one places the gelatine inside the spotlight, it will melt when used with a lamp of greater than 250 watt size. Oiling the center of the gelatine has the same advantage as oiling the ground glass. The writer has produced a successful soft edge with a disc of thin glass equal in diameter to that of the lens. With carborundum and water the glass disc is ground by hand, beginning part way between the center and the circumference of the disc. The grinding must be done gradually, decreasing the transparency and increasing the degree of grinding from the starting position to the circumference. In this way a disc clear in the center and gradually frosted toward the circumference is produced. To place the disc in position the lens is removed, and the disc is placed behind it. This change can be made in less than two minutes, and there is no danger of breaking the disc in transportation if it is left in

place. A thin disc is necessary for some spots which have very little more clearance space than that necessary for expansion of the lens. This is a more successful way of effecting a soft edge than the others mentioned. Another very good method of making a soft edge is to sandpaper whatever color medium is being used. The surface opposite the periphery of the lens should be scratched, leaving the center clear.

21. Stage Cable

A stage cable is a flexible twin conductor which consists of two bundles of fine wire each twisted into a heavier wire like a cotton cord constructed from fine threads. Each of these conductors is covered with insulating material (Ch. II, Sect. 5) consisting of rubber and tarred fabric. The two insulated conductors are finally covered together with more insulating material to form a single flexible cable. The safe size for such uses on the stage as connecting spotlights, floodlights, and any other movable unit whose total wattage is 1500 or less is the No. 14 wire which safely carried 15 amperes (Ch. II, Sect. 7).

Borderlight cable is made up of six or eight conductors to connect 3 or 4 circuits. It, also, is wrapped into a single cable. Armored cable, a well insulted twin conductor with a spiral form metal sheath is sometimes used for permanent wiring on the stage. Permanent wiring with wire less than No. 14 is forbidden by the code.

All non-professional workers should be warned against using cable of current carrying capacity less than the current through the load. It is both illegal and unsafe. For example, No. 14 wire is unsafe for arc spotlights because they draw from 25 amperes up to 100 amperes or more. Where the wire or cable is subject

to heat, asbestos covered wire is essential. Any of the lighting equipment companies listed in the appendix can supply all sorts of stage cable. A short table of wire sizes with corresponding ampere capacities is listed here for convenience. A more complete table can be found in any catalogue of lighting equipment.

Gage No.	Maximum Ampere Capacity
18	3
16	6
14	15
12	20
10	25
8	35
6	50

22. Plugs, Pockets, and Plugging Boxes

A stage plug is a heavy fibre block with a heavy strip of copper on each edge with screws for the connecting wire. A plug is attached to one end of a piece of stage cable (the other end of which is connected to a spot, flood, or other lighting unit) to be plugged into the source of electrical energy, that is, a wall, or floor pocket.

The pocket is a porcelain socket or receptacle of size and shape to receive the plug. The pocket has corresponding strips of copper to come in contact with those in the plug. The pockets for the floor or the wall are mounted in steel containers either singly or in groups of two or four pockets.

A plugging box is a portable group of pockets. It plugs into a pocket by means of a short length of extra heavy cable of high current carrying capacity with a stage plug on the free end.

Connected with a single pocket, it serves a number of lighting units which need not be separately controlled from the switchboard. Standard stage plugs, pockets, and plugging boxes are well made and will stand rough usage indefinitely, but they are expensive.

23. Stage Cable Connectors

Stage cable connectors are small blocks of fibre with contacts on one edge and a cable entrance on the opposite edge. They belong in pairs, a female part and a male part. The female part has two brass cylindrical openings which receive the brass prongs of the male part. These connectors are used in splicing lengths of cable together, to connect the short asbestos leads from a spotlight or floodlight to a length of cable, and to make any sort of connections from portable equipment to the source of electrical energy. The female part should always be on the "live" end (that connected to electrical energy) of a cable and the male part on the "dead" end. For example, the male part is always placed on the short leads from the lighting unit. Cable connectors are often used in place of pockets and plugs to save expense. The female half is connected to the circuit of a flexible control switchboard (Fig. 23) and the male half to the cable running to lighting units. The connectors are manufactured in different capacities but one of less than 15 amperes is very much restricted in use.

CHAPTER V

LIGHTING CONTROL

1. National Electrical Code

In planning the wiring of a new theatre building, in rewiring an old building, or in doing any sort of electrical work for the theatre, one should be thoroughly familiar with that part of the National Electrical Code concerned with theatre wiring, as well as general wiring practice, and with the recommendations of the National Board of Fire Underwriters concerning electrical devices which one is about to place in the building. As the National Electrical Code itself has no legal force, many cities have legalized it by statute, and others have statutes which are modifications of the Code. These regulations must be rigidly followed because any divergence from them is both illegal and unsafe. City electrical inspectors are required to see that all construction and repairs are done in accordance with the Code or law in force. Copies of the Code are free upon application to the National Board of Fire Underwriters in New York.

2. Kinds of Service

A theatre should have at least two electrical services, a general lighting service and an emergency service. Sometimes theatres have a third or power service. Where feasible, the emergency service and the general lighting service should be brought in from the street on different mains. If this is im-

practicable, the emergency service should be connected to a point on the street side of the fuses in the single main which furnishes energy for all of the theatre circuits.

3. Emergency Service

The emergency service is for the emergency lights which are lighted during the entire theatre program. They consist of the exit lights, aisle lights, part of the corridor, foyer, and stairway lights, and any others which are always lighted while the public is in the theatre. These lights are on a separate service so that accidents back-stage cannot interfere with a moderate amount of light to allow the public to find its way out in case of fire or accident. The Code states that these lights are controlled "from the lobby or other convenient place in the front of the theatre."

4. General Service

The general lighting service is used to light everything except the emergency lights. These are the ones for the stage, auditorium, offices, signs, toilets, dressing rooms, foyers, and lobby. A lobby cabinet usually takes care of the lamps in the foyers, lobby, offices, public toilets, etc. The stage switchboard controls the house (auditorium) lights, the stage lights, and the work lights.

The house lights, as the auditorium lights are usually called, are designed as a part of the decorative effect of the auditorium. Sometimes they are all white and sometimes elaborate color effects are worked out and displayed between acts. Indirect lighting and lighting from concealed sources like cove lighting are preferred, but direct methods are still in use. Whatever these

house lights are, they should be controlled by dimmers. A single dimmer is satisfactory because one usually wants to reduce gradually the intensity of all of the house lights just before the curtain rises. This helps to get the audience in the proper mood and to get them quiet and attentive for the first line of the play.

The work lights are the lights for all of the back-stage workers. They illuminate the fly floor, gridiron, work shops, dressing rooms, orchestra, property rooms, scene dock, greenroom, etc.

The stage lights, which have already been discussed, consist of borderlight, footlights, cyclorama lights, movable units which are plugged into stage pockets, and any other lights which are used for the illumination and decoration of a scene on the stage.

5. General Wiring Plan

Theatres are usually supplied from the street mains with 110–220 volt three wire feeders for the general lighting circuit and the emergency circuit. Each service must be supplied with a separate switch, fuses, and meter which are enclosed in steel cabinets or sometimes on open panels if located in a separate room. These panels or cabinets are the main distribution panels.

6. Three-Wire System

A three-wire system such as that used in theatres, takes the place of two circuits or four wires by having the center wire common to both circuits. This center wire is called the neutral. From either outside wire to the neutral there is an electromotive force of 110 volts, and from one outside wire to the other there is a force of 220 volts (Fig. 21). Fuses are always placed in each of the outside wires but a fuse is never placed in the neutral.

Figure 22 illustrates what would happen if the neutral were fused and a short circuit occurred in branch B. Two hundred and twenty volts would then be across the branch circuit A which probably would burn out all of the lamps. The neutral

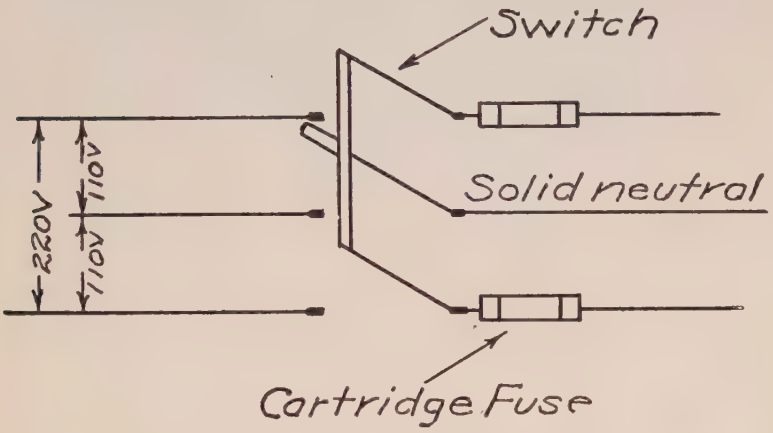


Fig. 21. Three-Wire Electrical Service
Showing neutral wire and 220–110 volt potential.

wire is always grounded, that is, connected to the ground at one or more places. See Code under grounding.

7. Requirements for Safety

The feeders from the main distribution panels go to the main stage switchboard, the emergency cabinet in the front of the house (mentioned above), and to other cabinets found necessary in the theatre. All of this permanent wiring must, according to the Code, run through approved conduit,[1] metal raceway, or armored cable (Ch. 4, Sect. 20). Fuses for each circuit must be placed according to the Code. The permanent wiring

[1] A metal pipe or channel in which wiring is placed to protect it and prevent fire.

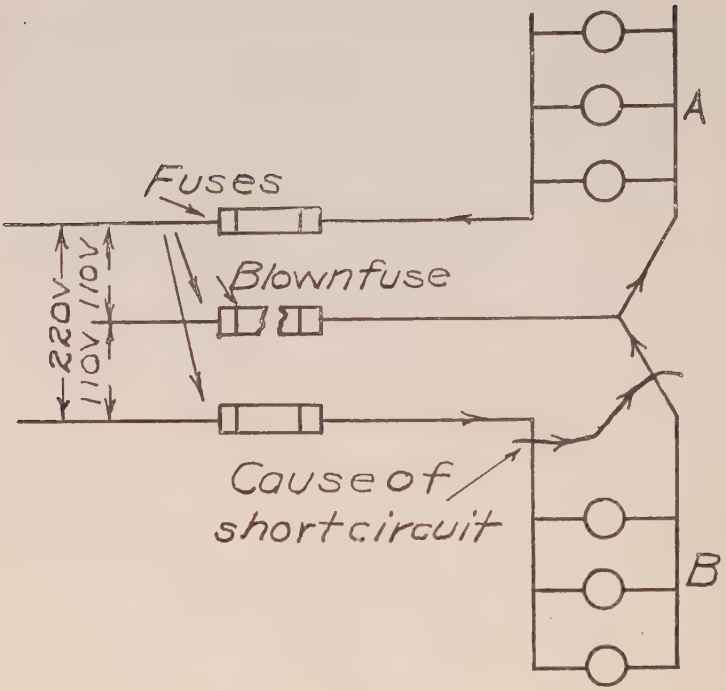


Fig. 22.

This shows what would happen if the two wires of circuit "B" came in contact or if a metal body fell across an uninsulated part of this circuit.

throughout the stage, such as that for wall and floor pockets, also must be enclosed in the same sort of metal sheath. This metal sheathing is grounded.

The diagram, Figure 23, gives some idea of the wiring lay-out of a theatre. This diagram, of course, is reduced to its bare elements in order to make it as simple as possible. The switch in the upper left hand corner is the main switch for the whole general lighting service discussed in Section 4. This switch is

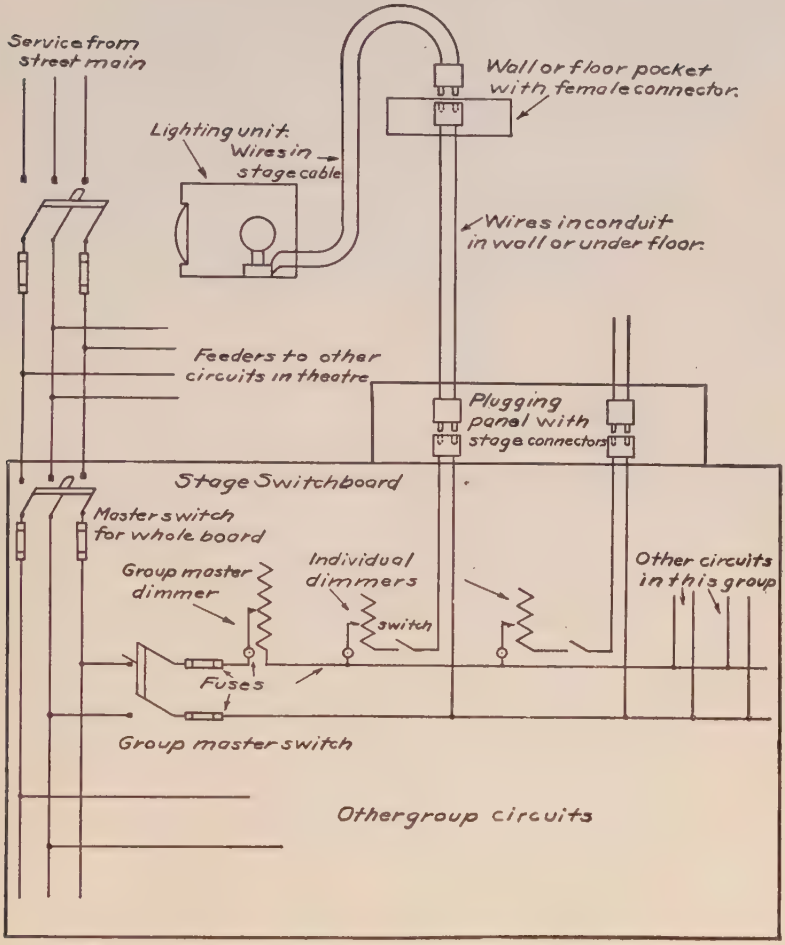


Fig. 23. Elementary Diagram of Stage Wiring Layout

found on the general distribution panel usually located in a basement room used only for this purpose. From this panel the feeder wires lead to all parts of the theatre, but the diagram shows only those which lead to the stage switchboard. The

switchboard shown is the flexible control type recommended in this chapter and discussed at greater length in Section 17. The wiring on the board will be discussed in a later section. The wall or floor pocket, placed at convenient places throughout the stage where lighting units can be connected, is shown in the diagram and discussed in Chapter IV, Section 21. This pocket is provided with female stage connectors instead of the standard stage pocket receptacles (Ch. IV, Sect. 22). The wires from the connectors in the pockets are carried in approved conduit to the switchboard plugging panel shown in Figure 23 where the male connectors on the stage circuits can be plugged into any one of the switchboard circuits.

Little Theatre people should remember that all of these requirements which apply to professional theatres also apply to the non-professional. The wiring in Little Theatres must pass the same inspection as the wiring in a professional theatre.

8. Wiring for the Future

Non-professionals sometimes are short-sighted in allowing a building to be wired with conductors which are barely large enough to carry a present load of very limited equipment. In a few years, when they are better off, more equipment is bought and all of the wiring is too small to carry the increased load. One must look to the future when wiring a theatre. Even an occasional elaborate production may demand a lighting load of five times that of the usual domestic drama. Wiring is expensive and rewiring a building already completed is far more expensive. See Chapter IV, Section 20 for minimum wiring requirement and consult the Code.

Further information on wiring can be obtained from books listed in the bibliography and from the National Electrical Code.

9. Switchboard Location

The location of the stage switchboard should be such that the operator will have a full view of the stage picture at all times. In a few theatres this is literally true. Occasionally one finds a theatre like the Century Theatre in New York in which the switchboard is beneath the stage floor and the operator has a place to look through the footlights trough. From this position he completely controls the switches and dimmer handles. At the Metropolitan Opera House the man who operates the slow motion grand master dimmer controller views the stage through such an opening in the footlight trough. From this position the operator certainly has a clear view of the scene, but it is almost impossible without enormous expense to design and build an elaborate board so compactly that one could sit in one position and reach every switch and dimmer handle. The switchboard operator who sat in position to see the scene would in most cases need assistance in handling the board. This makes giving orders necessary and light cues would suffer in promptness. Furthermore, the perspective is not correct when one is this close to the scene. To correct the perspective the operator may be placed with the board and equipment in the back of the auditorium or balcony. This position is probably dangerous because the operator is far from the stage, the stage manager, and the other members of the stage crew. The switchboard operator would necessarily have to be connected with his assistants by

telephone. The Theatre of the Golden Bough in Carmel-by-the-Sea, California, has the switchboard in the rear of the auditorium. The conventional place for the switchboard is at stage right near the proscenium, but there is no reason why stage left is not equally good. In fact many good theatres have the switchboard on the left. For example, the new University Theatre at Yale has the board on stage left. At either side near the proscenium on the floor level, visibility is sacrificed to a considerable degree. For certain kinds of settings the visibility might be better when the switchboard is on a platform about ten feet above the stage, but for box sets, which are used probably for more than half of the plays commonly produced, the elevated position is worse than on the stage level.

The elevated platform, it is true, keeps tired chorus girls from leaning all over the board. For the present, however, the best position, everything considered, seems to be on the floor level near the proscenium and on whichever side of the stage that seems to be best when the theatre is designed. When the switchboard is on the floor level some sort of rail should be placed around the front of it to keep idlers from interfering with the operator's movements.

It is very important that the architect know the exact size of the stage switchboard and where it is to be placed before he makes his detailed plans for construction. Architects and engineers have often built a proscenium arch in such a way that there was no proper space for the board. Many stage switchboards require a space large enough to have five feet from the front face of the board to the wall behind it. This is sufficient to accommodate the thickness of the switchboard including the dimmer bank and space enough behind the board to allow a workman to remove a dimmer for repair.

10. Switchboards Classified

The two main classes into which stage switchboards fall are direct control and remote control. A direct control board is one which carries through its switches all of the current which is being used on the stage. The switches which control the lighting units upon the stage are mounted directly behind the switchboard and are controlled by handles on the front of the board. In the remote control type the lighting switches which carry the actual load are mounted on a board remote from the stage and the control board. The control board, or pilot board, is the stage switchboard and is operated like any direct control board. When a switch is closed on the pilot board, a magnetic coil is energized. This coil closes the large switch in the lighting circuit. Thus there is a small pilot board, operated on the stage, which controls magnetic switches in a remote board usually placed under the stage.

11. Direct Control—Non-Interlocking Boards

A switchboard is said to be non-interlocking when each switch handle is independent of every other handle and when there is no method of opening and closing the handles together. There is no mechanical connector between these switches, but such a board is capable of having (and usually has) an electrical method, a master switch, which controls a group of two or more switches. For example, to control a four circuit border light there would be four individual switches, one for each circuit, and there could be a single large switch which would control from one to all four of the individual circuits when their individual switches were closed.

12. Direct Control—Interlocking Boards

On an interlocking type board a group of two or more individual switches is mounted on a shaft about which they can turn freely to open or close a circuit, or they can be interlocked to the shaft (usually by twisting the handle) and operated together by a master handle which is connected rigidly to an end of the shaft. A grand master lever is sometimes provided on an interlocking switchboard. This lever controls all of the shafts together, so that any or all of the switches on the board can be operated simultaneously. This is a very valuable addition to an interlocking board because every scene and every play present new and different designs which require different arrangements and combinations of foots, borders, floods, and spots which may have to be operated together. For instance, we may want to turn on together the blue foots, the green border, several hanging floods on different circuits, and four or five spots connected to various pockets. All of these would never happen to be connected to a single group master but would likely be connected to four or five different group masters which could be operated at once by a grand master handle. A stage master switch, of course, would do electrically what the grand master handle would do mechanically. Figure 24 is a direct control interlocking board.

13. Remote Control Switchboards

As was explained above, the remote control system consists of a remote board usually placed in the basement or other isolated room, and a pilot board on the stage at either side of the proscenium opening from which the remote board is controlled. Since the switches on the pilot board carry a small cur-

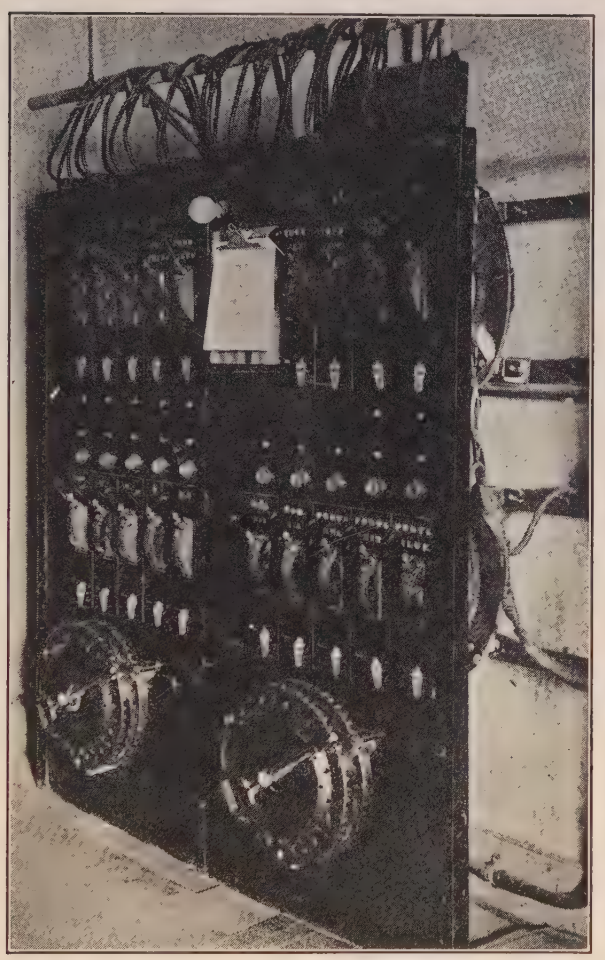


FIG. 24. SWITCHBOARD IN THE PLAYMAKERS THEATRE, UNIVERSITY OF NORTH CAROLINA

Master dimmer control designed by Charles E. Graham and Samuel Selden.

rent only (just sufficient to energize the magnetic coils) they occupy a space as small as one fourth to one half of the space

occupied by a direct control board. This saving of space permits the dimmer plates to be mounted directly within and behind the board with the operating handles projecting through to the face of the board, each handle below the switch that it controls. This arrangement simplifies the operation and convenience of such a switchboard.

Remote control switchboards can be designed as pre-selective which means that one or more complete lighting changes can be set up on the board in advance without interfering with the lighting of the scene in progress. Some boards are designed to pre-select as many as twenty lighting changes in advance, but it is perfectly evident that the occasion is rare, especially in Little Theatre practice, on which one has to make so many complete lighting changes in such rapid succession that the operator has no time between them. To have one change set up in advance is all that is necessary for the vast majority of lighting plots, and subsequent electrician's cue sheets, for Little Theatre productions. The following example illustrates how pre-selective remote control is operated. Before a performance begins the electrician operating a ten pre-selective remote control board could set up in advance ten scene changes in the following manner. Suppose for the first scene that the cue sheet called for blue and green footlights, blue border, pocket left No. 1, pocket right Nos. 2 and 4, left tormenter 1, 3, and 5, and right tormenter 2, 4, and 6. The operator goes over the board, turning on the No. 1 pre-selective switch for each of these twelve lighting circuits just mentioned. No lamps are illuminated, however, until the number one master is closed. For the succeeding scenes the number 2 pre-selector switches are set up and so forth to the limit of the switchboard. When the scene change is

made, the operator merely turns off one master and turns on another. The lighting change is made instantly.

The Frank Adam Electric Co. of St. Louis, manufactures several types of switchboards designed according to the Major System of Pre-Selective Remote Control. In general they operate

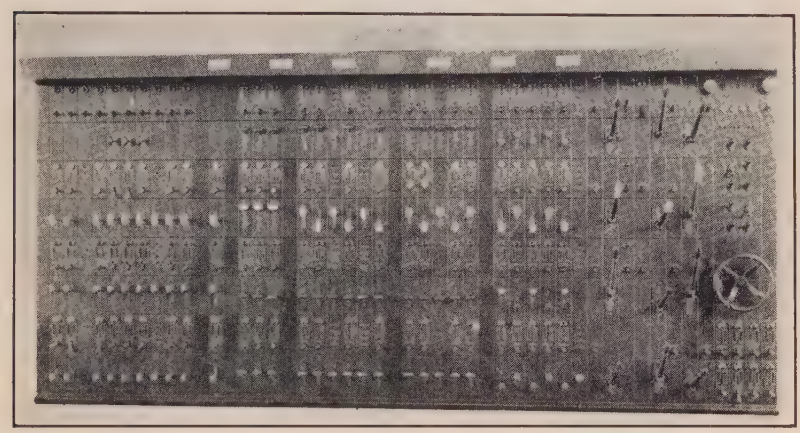


Fig. 25. A Remote Control Switchboard

according to the description above. The De Luxe Type built by this company is called a Ten All Master Remote Control Board which means as explained above, that there are ten pre-selective pilot switches for each unit, and of course, there is a master for each pre-selector group, making ten masters, each to operate a different light change. The masters can be operated together in various combinations to multiply the number of light changes which are possible. Figure 25 illustrates a Ten All Master Remote Control switchboard. There are a number of less elaborate remote control switchboards as well as modified remote control switchboards. Figure 26 is less elaborate.

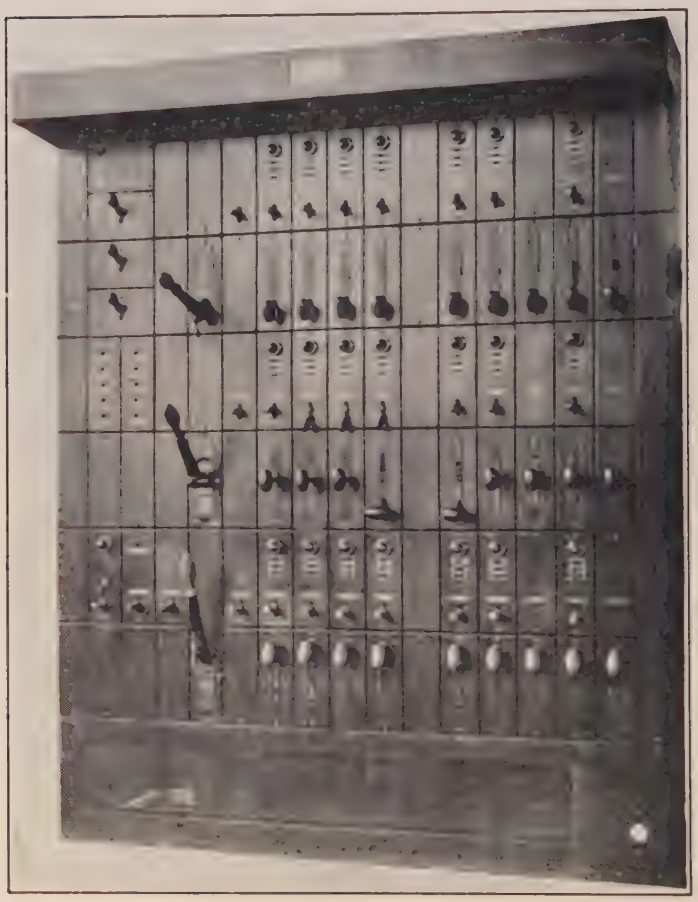


Fig. 26. A Small Remote Control Switchboard

14. Modified Remote Control

A modified remote control board (Fig. 27), which is particularly well suited to schools, clubs, lodges, and organizations who want a safe, simple, and fool proof switchboard to be operated by different people who are not experienced operators,

is made in this way. The individual circuits having a load of less than three thousand watts are direct control, but the master

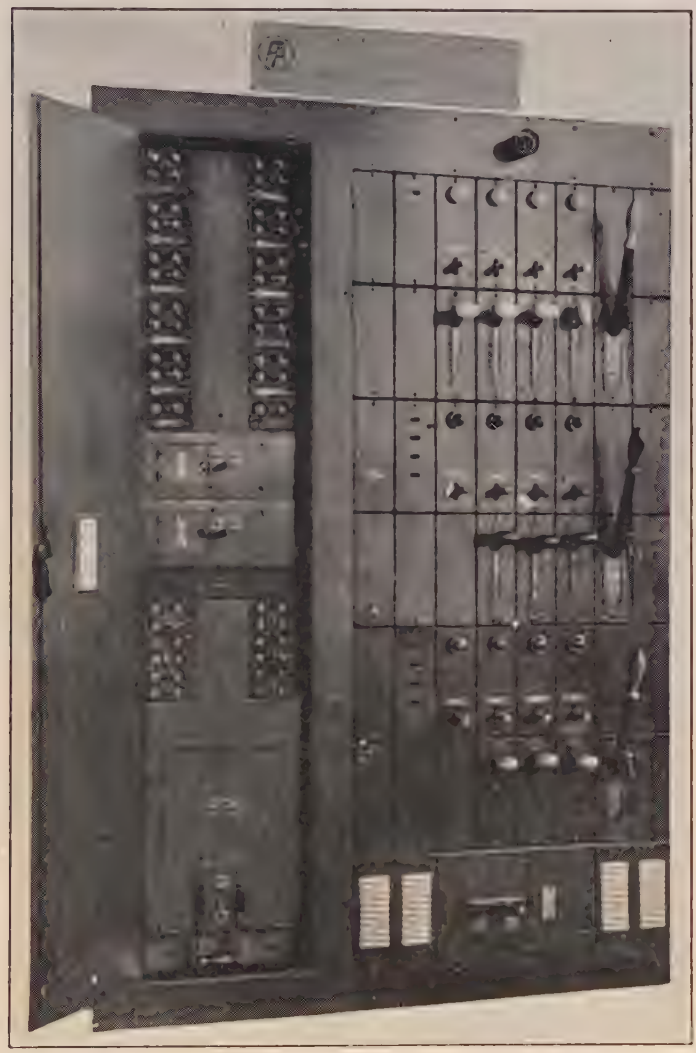


Fig. 27A. A Modified Remote Control Board

switch for a group of these individuals is a remote control switch. This master is made remote because switches designed for quick "make and break" carrying a heavier load than three thousand watts are nearly always too noisy to be on the stage. These boards are much cheaper than the full remote boards and are very satisfactory for productions requiring no very elaborate lighting effects.

15. Panel Boards

An inadequate but common means of lighting control often used on the stage of a school, college, club, or lodge auditorium is called a panel board. A panel board is composed of a group of tumbler switches [2] and fuses mounted in a steel cabinet. A panel board is comparatively cheap and is satisfactory for its intended purpose, a board for buildings where the lights are turned on and off once or twice a day. Being intended for purposes very different from the quiet operation necessary for even the most modest of dramatic productions, these panel boards are designed for further ineffectiveness by architects who are innocent of the simplest stage requirements.

Such a switchboard could be very much improved by connecting or reconnecting the switches, so that they will be arranged in groups with a master switch for each group. For example, the three or four switches controlling the footlights should be together and a master switch placed beside them to control them all. A stage master, also, is very important, and it should control the stage lights only, not the house lights, exits, and anything else which the designer happened to hang on it in a moment of mental aberration. Dimmers, of course, should

[2] They are similar to those used in dwelling houses.

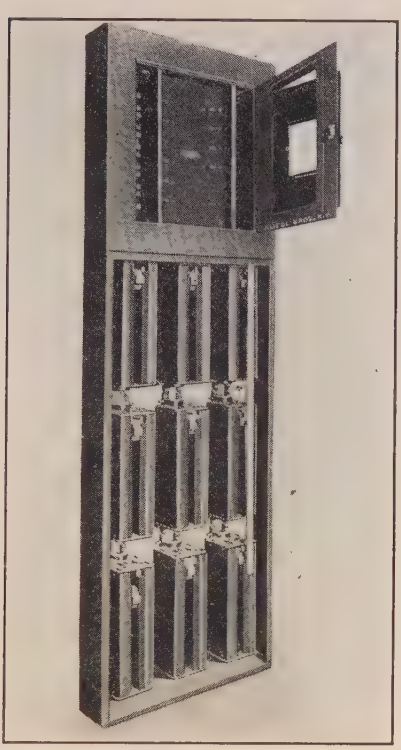


Fig. 28. Panel Board with Slide Dimmers

be built within (or beside) a panel board used for stage lighting, but dimmers with panel boards are exceedingly rare (see Fig. 28). A method of connecting dimmers temporarily to a panel board is suggested in Section 31.

16. Methods of Control—Permanent

All of the switchboards which have been discussed above are classed as the permanent type of control. By permanent control is meant a type of control in which the wiring that connects

the various circuits, like the borders, foots, pockets, etc., is permanently connected to the switchboard and the source of power. Furthermore, in permanent control there is no means of changing in any way the continuous circuits from the source of supply through switchboard, dimmer, lamp, and back to the source again, without considerably changing the wiring of the switchboard. This method of control has grown out of the professional theatre system of building theatres with certain stock units, such as several borderlights, footlights, and several pockets right and left. These, being considered the backbone of lighting any production, are always connected permanently to the switchboard. This is one of the reasons why a road company that requires any special lighting always carries its own lighting equipment and entirely ignores this stock stage equipment and even the switchboard in most instances.

17. Methods of Control—Flexible

In flexible control the feeders from the street are brought in and connected permanently to the board as in permanent control, and the general wiring of the board itself might be the same with this exception. A sub-feeder, including the switch and dimmer, is not connected permanently to a circuit such as red footlights, but this sub-feeder terminates in a female connecter along with other female connectors in rows along an edge of the switchboard or on a separate panel. (See Figure 24, and notice the row of connectors along the top of the board and Figure 29 where they are in the center.) All of the unit circuits on the stage such as the four border light circuits, various pocket circuit, footlight circuit, and so forth terminate in male connectors near enough and with sufficient free flexible cable to

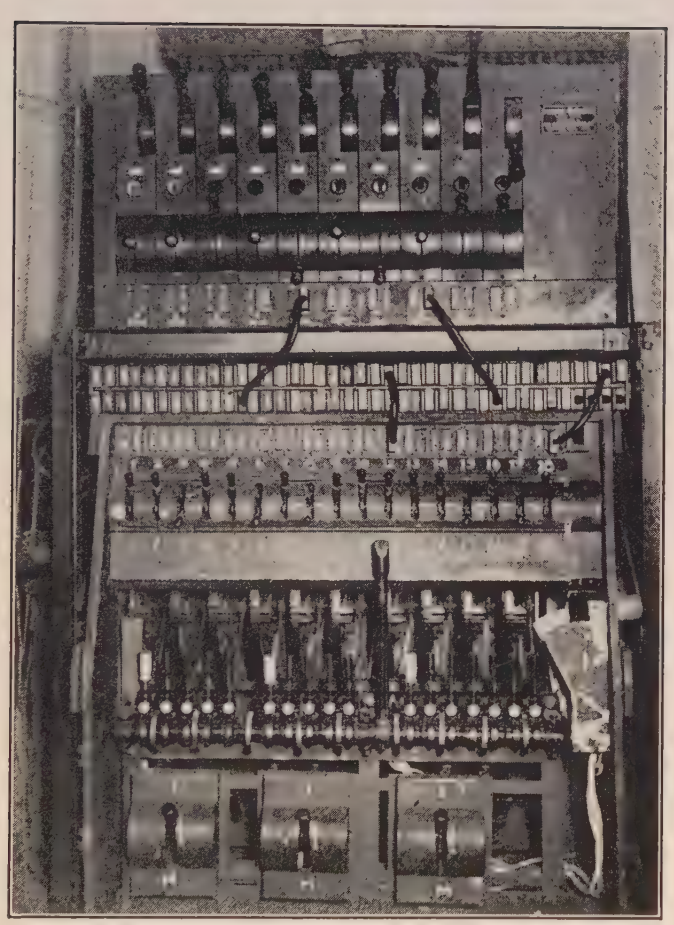


FIG. 29. PORTABLE SWITCHBOARD

In the small experimental theatre under the main auditorium at the Yale University Theatre.

allow plugging into any of the female connectors (Figs. 24 and 29). This scheme makes it possible to connect any unit on the stage with any switchboard circuit. Therein lies the flexibility

of this type of wiring so necessary for really modern stage lighting methods. Footlights are not required for every production; so why tie up four dimmers by connecting them permanently to the footlights? The same can be said for any other unit on the stage. Moreover, in the case of pockets, a lamp of 250 watts may be used in a certain pocket for one production, and a 1000-watt lamp may be attached to that pocket for another. Furthermore, with flexible control a dimmer of proper capacity can be connected at will to any lamp circuit. The switchboard in the Playmakers Theatre at the University of North Carolina shown in Figure 24 is a good illustration of flexible control on a small switchboard. The switchboard in the new University Theatre at Yale is an example of flexible control applied to an elaborate switchboard. Figure 29, the portable board in the Yale University Theatre, is also an interplugging flexible type.

18. Advantages of Flexible Control

Flexible control appeals to Little Theatres for three important reasons. First, Little Theatres are interested in modern artistic lighting to which flexible control lends itself far better than permanent control. Second, Little Theatres are experimental theatres interested in new experiments in lighting which are far easier to do with flexible control. Third, Little Theatres are usually interested in finding the cheapest means of control which is capable of the sort of results they are interested in attaining.

(1) Flexible control assists in producing artistic lighting because it allows the right lighting unit, connected to the proper dimmer, to be stationed in a desired position. When the unit is in that position, it can be plugged into the nearest pocket, and

this pocket can be connected at the switchboard to a dimmer of wattage capacity equal to that of the lamp in the unit. In this way extra long pieces of cable, draped all around the stage can be avoided.

(2) Experimenting for the best effect usually causes delays and wastes time. Time can be saved and inconvenience can be reduced by the accessibility of the connectors near or on the switchboard when one is trying different spots and lamps to produce a certain form and intensity of light. Two or more units can be connected easily to a single dimmer with a paralleling plug used with the connectors on a flexible board.

(3) A flexible control board is cheaper because the number of dimmers need not be as large as the number of circuits. If every circuit is capable of being connected to a dimmer, the dimmers, although small in number, are always available wherever they are needed. One, knowing the limitations of the particular stage, the nature of the plays which the group produces, and the amount of money available, can decide, with fair judgment, upon the number of dimmers, their capacity, and the number of circuits which are to be connected to them. Half as many dimmers as circuits should give satisfactory control.

19. A Typical Switchboard Design

In order to make the discussion of flexible control switchboards more concrete and more useful to one who is planning a switchboard for a Little Theatre, such a switchboard has been designed to illustrate the problems more clearly. Since it is necessary to understand dimmers before one can completely

understand switchboards, the reader should review Chapter III and refer, when anything about them in this section is not clear, to the second part of this chapter which deals specifically with dimmers.

Let us assume that the switchboard is for a small stage 30 feet wide, 18 feet deep, and proscenium 18 feet wide and about 14 feet high. We shall want four circuits for the footlights, four for the ceiling beam (Ch. IV, Sect. 2), four for a borderlight and two extra circuits on this batten for spotlights (making six), four for a second batten for spotlight or flood lights, three circuits on each side of the proscenium for the tormentor lights (making six), and three floor pockets of two circuits each, one pocket on stage left, one on stage-right, and one up-stage center. This makes a total of thirty circuits and it would be better to have none of them permanently connected, not even the border light and footlight units. If these circuits merely terminate in stage connectors to which any unit can be connected, it will add much to the flexibility of the whole stage layout. Let it be understood that the writer has not stated arbitrarily that thirty circuits are necessary for a stage of this size. Perhaps twenty would be enough, but it is convenient to have connectors or pockets where they are needed without running long lengths of cable all around the stage to a pocket on the opposite side when all of them are in use on the side where the light is wanted. It costs very little more to have three or four more circuits when all of the wiring is done, but to add that many circuits after everything is finished is very expensive.

We know by experience, however, that the average production on such a stage uses about half of these circuits; so if the producing group that owns the theatre is poor, it need not build a switchboard with as many as thirty circuits. On the other

hand, fewer switchboard circuits than stage circuits does not mean a make-shift, for this board is to be one of flexible control of modern design.

On this basis the present switchboard is designed with sixteen dimmers capable of being plugged into any of the thirty stage circuits. The front of the board is illustrated in diagram in Figure 30. This switchboard is made in two groups of circuits with a master switch for each group. The general plan of the board in each group is to have a master dimmer, a dimmer of large capacity, which will dim a group of individual dimmers (Sect. 28) but which will also be useful as an individual dimmer itself by throwing a transfer switch. In the upper panel there is a row of switches and a corresponding row of dimmers. The first switch at the left is the transfer switch. On its up throw the dimmer A is a master dimmer, and on its down throw it can be used as a individual dimmer on any circuit. The next switch is used to connect this large capacity dimmer, 3000-watts, to the house lights (thus saving an additional dimmer for the house lights) on the down throw and to the stage circuits on the up throw. The other ten switches control eight individual dimmer circuits and two circuits without dimmers. Now dimmer A can be used as a master for any or all of the individuals, one to six inclusive, but 7 and 8 are not controlled by the master. It often happens that one wants circuits separated from the master; so 7 and 8 of group A and 5 and 6 of group B are not connected to a master. Group B is similar to group A except in the wattage of the various dimmers and the number of dimmer plates and the combination of dimmers connected to the master. The variety of wattages connected to the two masters is intentional because these combinations have been found especially useful in practice.

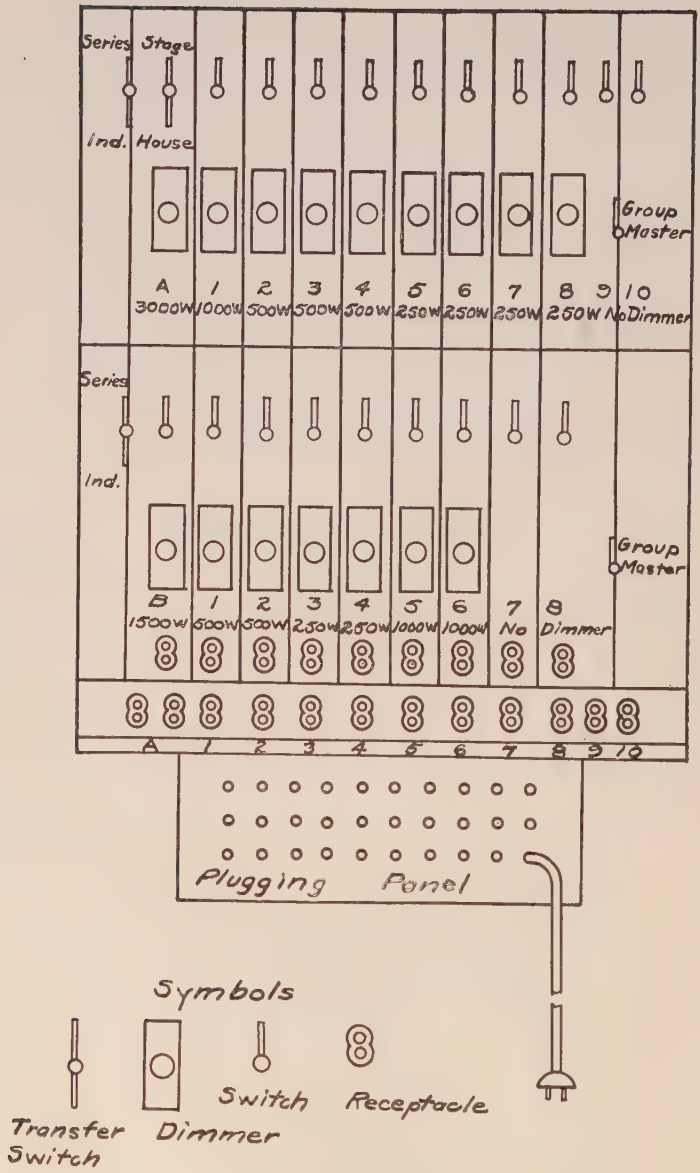


Fig. 30. Diagram of Typical Little Theatre Switchboard

The plugging panel is the terminus of the thirty stage circuits, and each circuit has a short length of cable (about 36 inches) and a male plug which will reach any of the switchboard circuits in the two rows above. In this way any stage circuit can be connected quickly and easily to any switchboard circuit. In Figure 30 the plugs and receptacles are of the heavy

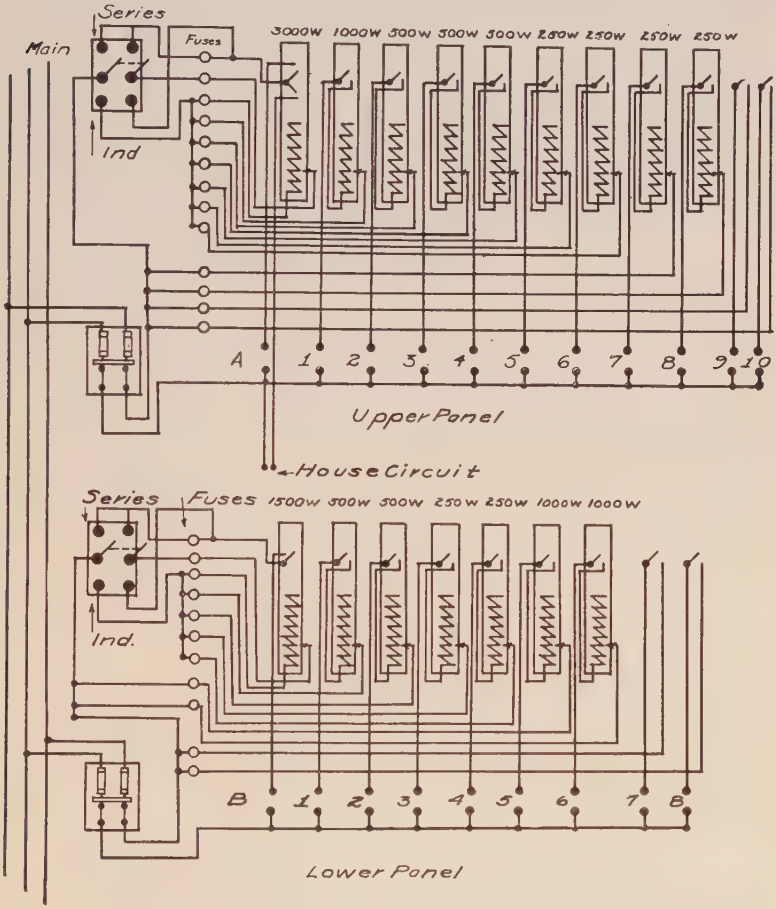


Fig. 31. Schematic Wiring Diagram for Switchboard in Figure 30.

duty General Electric type convenience plugs and receptacles which are somewhat cheaper than stage connectors shown in Figures 23, 24, and 29. For light loads, like the case under discussion, the G. E. type is entirely satisfactory.

The wiring diagram, Figure 31, for this switchboard seems a bit complicated on casual observation, but if one approaches it boldly and systematically, it resolves itself into quite well known elements. From the diagrams and discussions in Chapter III and in this chapter the reader knows what series and parallel elements are, he knows what a three-wire system is, and from his personal experiences he knows what fuses are. With this information and that obtainable in Figure 23, he can easily trace the path of the current in any of the circuits. Omitting the transfer switch and its wiring, which complicate Figure 31, a single group circuit is clearly shown in Figure 23. Here is the group master switch, and following along the upper wire from this switch, one traces the path of the current through the fuse to the master dimmer which is in series with the whole group as it is shown here. From the master dimmer the current is fed to the various individual dimmer circuits. For one typical individual dimmer circuit, the curernt goes through a fuse, the individual dimmer, a single pole switch (marked on the diagram) and then to the female connector at the plugging panel. When the male connector is plugged in, the current goes on to the pocket shown at the top of the diagram. If a spotlight is plugged into this pocket, the current continues to the spotlight, through the filament of the lamp, and returns in the other wire to the pocket, the plugging panel, and back of the lower wire of the feeder for this group. The complete circuit includes the passage of current through the mains and back to the central power plant.

Notice that the individual dimmer circuits are across the group feeder, that is, in parallel with it, but that the master dimmer is in series with the several individual dimmer circuits. If one understands this thoroughly, he is ready to refer to the wiring diagram in Figure 31. Taking the point where the group feeder leaves the left wire of the main, one follows the path of the current through the group master switch, which is closed, and then straight up to the transfer switch. The wires that branch off before they reach the transfer switch go to the circuits on this group that cannot be controlled by the master dimmer. If the transfer switch is closed to the up throw, the current goes right around the upper terminals, which are wired together, and back to the opposite middle pole of the switch. From there, the current goes through dimmer A, the master, and then back to the group of fuses where it branches off to the several individual dimmers. Then the current is easily traced through an individual dimmer and its switch down to the terminals at any one of the numbers. These terminals are the receptacles on the front of the board shown in Figure 30. From the receptacle, or female connector, in the diagram in Figure 23 the current has already been traced through a pocket and lighting unit. If one draws a single circuit on a sheet of paper as he traces the diagram, so that he gets a single circuit separated from the mass, Figure 31 will seem much clearer. The diagram really is simple, but having a number of wires close together makes it look confusing.

This gives one a small, compact, and comparatively inexpensive switchboard about three feet wide and four and one half feet high. The capacity of the dimmers is sufficiently high for any lamp load one would ever use on a stage of this size or

even one somewhat larger. The dimmers are non-interlocking in order to save expense; interlocking ones would not add a great deal of convenience to such a board as this one. Having only two group master switches makes an additional stage master switch unnecessary because one can easily operate the two together. The same is true of the master dimmers which can dim all of the stage lights at once as a single master dimmer might, but, better than a single master, two will allow one to increase one group of units in intensity while he decreases another group.

The switchboard in the Playmaker's Theatre at the University of North Carolina (Fig. 24) has two master dimmers to which any one or all of the dimmer circuits can be connected by a small single pole double throw switch similar to the switch at the top of the 3000-watt dimmer in Figures 30 and 31. This is a very good method of connecting master dimmers, but they should be multi-capacity (described in Section 30).

The switchboard described and discussed in this section and illustrated in Figures 27 and 28 is the type which is best suited to the needs of the small theatre of limited funds. The same principles can be elaborated to any size, and the board will still be a desirable type. If it were considerably larger with quite a few more dimmers, the dimmers should be interlocking and the group master switches should be remote control, making it a modified remote control switchboard. When a much simpler board is needed, a portable switchboard is probably more suitable than a stationary one.

20. Portable Switchboards

The portable switchboard, which is used by many traveling shows that cannot depend upon the switchboards found on the

road, is another application of flexible control. A portable board appeals also to the Little Theatre organization that produces in an inadequately equipped building other than its own. Many groups with little money are forced to rent an auditorium or different auditoriums six or eight times a year, and nearly all of these places have no more lighting equipment than a small panelboard. Such Little Theatre organizations will find a portable switchboard admirably suited to their needs.

A portable switchboard consists of a box or trunk within which is mounted the switches, fuses, dimmers, and connectors with sufficient wiring to distribute the power properly from a two wire or three wire feeder to the various lamp circuits in use for a play.

The container, box or trunk, can be of any size sufficient to accommodate the contents, but it should be designed for ease of handling, convenient operation of the connectors, switches, and dimmers within, and for the proper protection of its contents.

The switches should be quiet in operation. Knife switches are the cheapest quiet ones, but they must be enclosed in metal for safety. The connectors can be of several types. Figure 32 shows a portable board used in professional theatres. The connectors here are standard stage pockets and plugs. These are the most expensive and are entirely unnecessary for a non-professional board. The best connectors to use would be the standard stage connectors, but many non-professional portable boards are equipped with common convenience plugs and receptacles used in house wiring and domestic electrical appliances. The heavy duty type should be used. Asbestos covered wire of sufficient capacity should be wired in metal channels to comply with the Code. Fuses of either the cartridge or the plug type should be

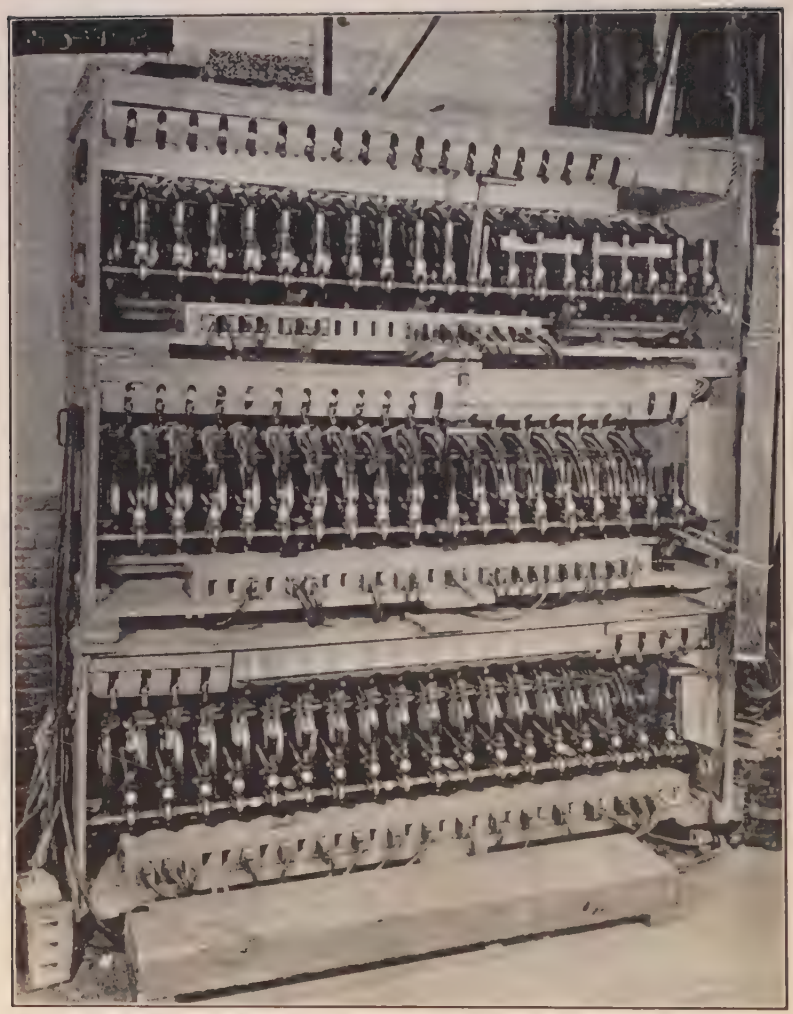


Fig. 32

This is a typical professional portable switchboard built in three banks for convenience in shipping. Each row of dimmers is interlocking with a master handle. Each bank has its own row of stage plugs and receptacles. A plugging box is shown in the lower left corner of the illustration.

provided in all circuits. A portable board might be wired like the diagram in Figure 23 with this difference. Instead of having a plugging panel, one could have merely a row of female connectors into which the male connector from the lighting units themselves could be plugged directly. Figure 29 is a more elaborate portable board of the interplugging type with stage connectors, but the plugging is done in much the same manner as in the stationary board discussed in Section 19.

The dimmers can be connected in several ways. Each dimmer might be connected permanently in a sub-feeder like the stationary board in Figure 23 or the dimmers may be provided with a flexible cord and plug to be plugged into any circuit desired. Either the slide type or the disc type of dimmer will be found satisfactory according to the size and shape of the portable board (see Part Two, Ch. V for dimmers).

Portable switchboards are connected to a source of power through a "company switch" if one is available. This is a switch placed in a small metal cabinet or sometimes on the stage switchboard, and is provided with terminals or plug and pocket to connect the portable board. The "company switch" is connected in the main feeder or in a sub-feeder from the switchboard. In a panel board one may have to tap the three wire feeder within the panel to obtain a source of power for a portable switchboard.

E. Dimmers

21. Introduction

The importance of dimmers to stage lighting is exceeded only by that of the incandescent lamp itself. This lamp and electricity, which were to revolutionize all lighting throughout the world, were looked upon with considerable skepticism by thea-

trical producers and actors in the early days of electric lights. For some time after electricity was introduced on the stage, gas was a greater favorite because it could easily be controlled by turning a valve. Electricity without control was inferior to gas, and before the invention of the rheostat, electricity made little progress on the stage. Now, however, with simple control easily available, Little Theatres that are struggling along without dimmers are unconsciously trying to compete with the gas lights of half a century ago.

22. Resistance and Reactance

The intensity of light can be controlled either by resistance or by reactance. The resistance method is in far more general use.

Reactance Principle: To control the intensity of light by the reactance principle, a coil of insulated wire, with a movable iron core, is connected in series with the lamp. When current flows through the coil with the core within the coil, the lines of force threading the wires of the coil pass freely through the iron core, and an electromotive force is set up in the opposite direction to the line voltage which caused the current to flow. The result of these opposing electro-motive forces is a very much smaller voltage across the lamp; so the lamp is dimmed. As the core is removed from the coil, fewer and fewer lines of force pass through the core, a smaller back electromotive force is set up, and when the core is entirely removed, the lamps have their normal brightness. With this method there is almost no heat lost, and only that power is being consumed which is used to light the lamps. This saving in power immediately appears to

be an advantage for the reactance method. On the other hand, a control unit employing the reactance principle is much larger and more expensive than a resistance dimmer of equal capacity. These two disadvantages, size and expense, in most cases offset the advantage of saving power. In such very large control systems as the Cleveland Auditorium, with a load of 900 kilowatts, and the Roxy Theatre in New York, with a load of 750 kilowatts, reactance dimmers manufactured by the Ward Leonard Company were preferred to the resistance method of control. These reactor units consist of a laminated iron core wound with A. C. coils connected to the load and a D. C. coil which is connected to a small rheostat within the switchboard on the stage. The dimming is done by varying the resistance in the small rheostat on the stage. The reactance units are set in a place remote from the stage.

Little Theatre electricians can wind a reactance coil of the kind mentioned first without great difficulty, but they are bulky and difficult to operate in groups. The second kind which needs both A. C. and D. C. power does not appeal to the non-professional. While reactance dimming may be occasionally useful in Little Theatres, they will find resistance dimmers cheaper and better suited to their needs in the vast majority of instances.

Resistance Principle: The resistance method of light control depends upon changing the amount of resistance, in series with the lamp, which changes the electromotive force across the lamp terminals. This causes a different amount of current to flow through the lamp filament and makes a difference in intensity of illumination. When the lamp load is dimmed out, the dimmer is absorbing about a quarter of the normal "full up" wattage of the lamp. This is dissipated as heat.

23. Dimmer Construction

The resistance unit for general theatrical work is a high resistance wire bent in the most compact shape with a number of contact buttons mounted at regular intervals along the wire. One type of unit is mounted on a steel disc about seventeen inches in diameter, then covered with a coating of vitreous enamel, and finally fired in a furnace at a much higher temperature than the unit would ever reach in practice. The proximity of the resistor element to the steel disc, promotes rapid dissipation of the heat generated when the resistor is in service. The vitrous enamel, which completely surrounds the resistor element, protects it mechanically, electrically, and chemically from depreciation. The adjustment of resistance is accomplished by means of a contact arm which bridges two concentric circles of contact points. In the non-interlocking dimmer, the operating handle sweeps through the same arc as does the contact arm when it moves over the contact points, but in the interlocking type the contact arm is rotated through a flexible drive, which multiplies the motion of the hand several times. This arrangement transforms the straight line motion of the operating lever into rotary motion of the contact arm. Figure 33 shows a bank of plates with rows of contact buttons and the contact arms.

24. Interlocking Dimmers

The interlocking type plates are usually mounted in one or more rows on a steel angle-iron frame in front of which the individual plate handles are mounted on steel shafts. For modern switchboards the frame supporting the dimmer plates is designed to be placed behind and within the stage switchboard,

and the dimmer handles extend through to the front of the switchboard (Figs. 24, 25, and 26). Each handle has a latch which permits it to be either hooked to the shaft for master con-

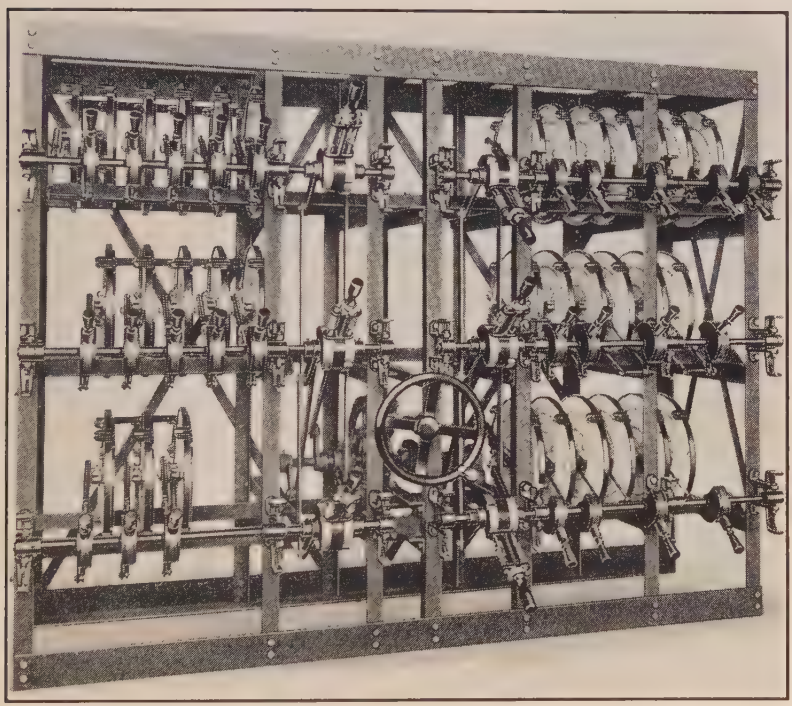


FIG. 33

A bank of Ward-Leonard dimmers before it has been set in a switchboard. The interlocking shafts, master handles and slow motion wheel are clearly shown.

trol or rotated freely for individual control. Master control is provided by a handle fixed rigidly to the shaft, and any two or more individual handles, which are on the shaft and latched in, can be moved as one by the master handle. Another device con-

nects two or more rows of dimmers together, so that any group of plates or all of them can be operated together. This is grand master control. Furthermore, the entire bank of plates can be connected to a slow-motion worm and gear operated by a hand wheel on the front of the board. This slow-motion wheel permits very gradual changes in intensity. Some dimmer banks are provided with "cross interlocking control" which permits one group of lamps to be increased in intensity while another is being decreased. This change is usually done with the slow-motion wheel.

25. The Flipper Switch

A recent addition to interlocking dimmers is a "flipper switch." It is a "quick-make and break" switch placed on the rim of the disc where it can be operated by the contact arm as it rotates over the contact buttons. As the arm moves across the last "live" button to black out, the circuit is broken in the "flipper switch" rather than between the button and contact arm where arcing would take place. This saves power and makes the additional operation of opening the circuit switch unnecessary.

26. Non-Interlocking Dimmers

Non-interlocking dimmers are manufactured on discs of different diameters up to seventeen or eighteen inches, and they do not differ radically from the interlocking type. Non-interlocking dimmers differ principally in the rotating arm which goes through a large arc when the resistance is varied. This type has fewer steps, or contact buttons, making the dimming less gradual. A square type is sometimes used for theatrical work, but it has fewer steps than disc types.

27. Slide Dimmers

The slide type dimmer which is occasionally mounted in a switchboard (Fig. 28) is more commonly mounted on the stand of a spotlight or floodlight for individual control of the unit. The slide in some of these dimmers comes directly in contact with the coil of wire. This often makes a squeaking noise which can be heard far out in the house. Others of this slide type have the wire completely concealed and the slide moves noiselessly over contact buttons. These non-locking type dimmers, both disc and slide, being very much cheaper than interlocking ones, appeal to the theatre with limited funds. Non-interlocking dimmers produce very satisfactory results if they are used with one or more master dimmers.

28. Master Dimmers

With a master dimmer one can do electrically what is done mechanically by the interlocking mechanism used with interlocking dimmers, and it has an additional feature which makes it superior. If one desires to change the intensity of six groups of lamps simultaneously by means of non-interlocking dimmers, three operators would be needed. If there were fifteen or twenty dimmers, quite a large stage crew would be necessary for this purpose alone. Fortunately, a master dimmer, connected in series with all of the individual dimmers and circuits to be controlled, will accomplish this task of dimming all of these circuits together, and it can be operated by one man. This master dimmer must have a wattage capacity equal to the total wattage of all the load connected to it. This is the total wattage rating of all of the individual dimmers connected to these different lamp loads.

A small switchboard wired for flexible control is sometimes divided into two groups of circuits, each group having a number of individual dimmers controlled by a master. A single operator can manipulate two handles simultaneously, and two masters are superior to one in that one group can be decreased in intensity while the other is being increased just as in cross-interlocking control. This is possible, however, with a switchboard wired for flexible control only (Sect. 19).

The additional feature which makes a master dimmer superior to mechanical interlocking is called proportional dimming. Suppose a master dimmer were connected to four individual dimmers which were set at different reading, "full up," one-fourth dimmed, one-half dimmed, and three-fourths dimmed, for example. With the master dimmer one could dim this group proportionally, that is, change the intensity of the whole group without changing the relative intensities of the lamps controlled by these four individual dimmers. Proportional dimming is a very valuable addition to any switchboard especially when one uses the three color system (Ch. VII).

29. Dimmer Adaptations

Non-interlocking dimmers are manufactured in standard sizes which are not always just the capacity of the load to be dimmed. It has been stated before that the dimmer should not be over-loaded because of the danger of burning it out, but no harm will result from using a dimmer of greater capacity than the load (Ch. II, Sect. 9). Suppose for example, that the only dimmer available for a 500-watt spotlight is a 1100-watt dimmer. This dimmer is safe with the load, but it will not dim

the spotlight "black out." If complete dimming is necessary, it can be accomplished by building up the load with another 500-watt lamp, or lamps aggregating about 600 watts, placed in parallel with the spotlight, but concealed off stage, so that the illumination from these additional lamps will not interfere.

Suppose a 1000-watt spotlight is to be dimmed and two 500-watt dimmers are the only ones available. These two dimmers could be wired together in parallel, and the pair wired in series with the spotlight to dim it properly. It is very important, however, that the contact arms of these two dimmers be moved together. If the total resistance of one were put into the circuit without moving the other, both of these dimmers would probably burn out, one after the other.

30. Flexible Dimmers

For stage pockets, or any circuits, into which spotlights, and floodlights of various loads are plugged, dimmers of different ratings are needed. This is taken care of, for the most part, with a flexible control switchboard, but if the circuits are permanently connected, a "flexible dimmer" is needed. "Flexible dimmers," also called dual or multi-capacity dimmers which are now being manufactured for this purpose have, for example, resistance enough to dim a 500-watt lamp "black out" and current capacity enough to control a 1000-watt lamp. They are also made in 1000 to 2000-watt capacity. The disadvantage, however, lies in that the control handle will have moved only two thirds its travel when it has completely dimmed a lamp of maximum wattage for the dimmer. This, to be sure, restricts gradual dimming.

31. Dimmer Connections

In discussing switchboards wired for flexible control it was stated that in such switchboards any stage circuit could be plugged into any dimmer circuits on the switchboard. Getting dimmers of different capacities into any stage circuit can also be accomplished by approaching the problem from the opposite direction. Instead of having the dimmers connected to the switchboard feeders, the stage circuit can be directly and permanently connected to the feeders with a means provided for plugging the dimmers into the various stage circuits. Designs have been made and permanent stage switchboards built with devices [3] for connecting dimmers in the manner just discussed, but this method is more suitable for portable non-profesisonal switchboards and for connecting dimmers to panel boards and other switchboards without dimmers.

For either purpose a convenient length of twin conductor of sufficient current carrying capacity is connected to the terminals of the dimmers. To the other end of the conductor a common split plug (not a stage plug) is connected if the fuses on the board are plug fuses. A plug fuse is removed from the circuit on the switchboard and the dimmer plugged in its place. This places the dimmer in series with the lamp load as it should be. Since it is now common practice to use only one fuse in each circuit, another fuse in the dimmer leads must be provided when the fuse is removed from the board. If one wishes to plug dimmers into a board wired for cartridge fuses, the dimmer leads can be soldered to the ends of a "blown" cartridge fuse which is to be plugged into the fuse clips in place of a cartridge

[3] There are a number of these. One is illustrated and discussed in University of Arizona bulletin, *Stage Lighting*, by H. D. Sellman.

fuse. These lead wires that connect the dimmer to the board will be subject to the heat of the dimmer plate and, accordingly, should be asbestos covered.

An additional convenience for a portable switchboard which is designed to plug dimmers into various circuits, as explained in the above paragraph, is called a "by-pass." The "by-pass"

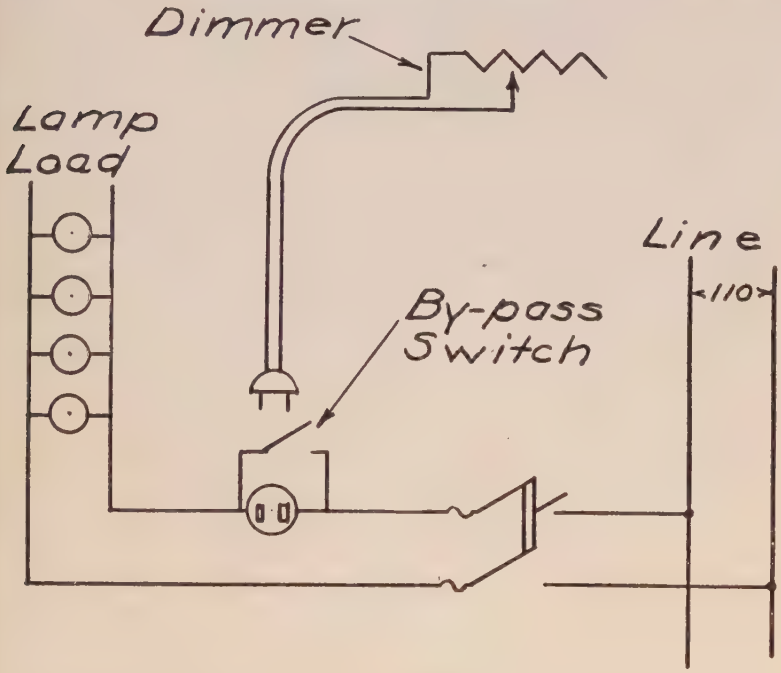


Fig. 34. Dimmer

Ready to be plugged into lighting circuit with "By-pass" switch.

consists of a single pole knife switch, or some other means of opening and closing the circuit, wired in parallel with the receptacle for the dimmer plug. When the lamp is "full up," this "by-pass" allows the dimmer to be plugged in or out without breaking the circuit. Figure 34 illustrates this diagramatically.

32. Conclusion

In this chapter as well as in the chapters on switchboards, wiring and lighting equipment, much of the equipment that is used in professional theatres as well as in Little Theatres has been mentioned. Little Theatres range from the group that occasionally rents a poorly equipped school auditorium for one production a year to the group that owns a theatre better than most professionals can boast and produces thirty or more plays a year. For this reason many kinds of equipment have been discussed, but more emphasis is placed on equipment for the group of limited means producing in a small theatre. All Little Theatre workers should be familiar with various types of equipment even if they do not have an immediate need for them. Most of the suggestions and hints in handling apparatus are included with the discussion and description. The information in the above chapters as well as in the succeeding ones is not intended to be exhaustive but to be helpful to those of limited experience and knowledge.

CHAPTER VI

LIGHT AND SHADE

1. Introduction

In art there are certain definite ways of effecting contrasts, but all of these are subordinate to the fundamental principle of contrast between white and black or light and shade. In stagecraft, if not in all art, light and shade are of supreme importance. Furthermore, light and shade in lighting must be sychronized with light and shade in the other elements in the production of a play, with light and shade in the text, the acting, the music, and the setting. And shade itself, or shadow, will find emotional and æsthetic expression in any properly lighted production. Many Little Theatre workers, and indeed professionals also, have overlooked this fundamental part of lighting design and have concerned themselves with light for no other purpose than that of enabling the audience to see the play. (Sometimes they have a great deal too much light for this purpose rather than just enough.) Perhaps they have never associated nature herself and her contrasts in light and shade with the *mise en scene*.

2. Nature

If one will look around him, examples of light and shade will appear on every hand. In fact they are so common and so close to us that we ignore and overlook them. Bright sunlight, sifting through shade trees of many varieties, produces a great diversity

of leafy patterns on green carpets of grass and on the walls and roofs of buildings. The shadows of vines and flowers add interest and beauty to flat surfaces of tables, chairs and other properties in patios and gardens. Likewise the multi-shaped shadows of buildings, large and small, add something to nature's shadow groups. The action of a Greek play took place during the span of one day, often beginning before dawn and ending after twilight, and ever since the days of early drama, plays have been concerned with dawn, midday sun, evening shadows, and black night pierced with shafts of moonlight.

Let us consider, then, the changes in light and shadows in the course of a day. First comes dawn with its faint diffused light and its dark, indefinite shadows that merge gradually into well defined objects chiseled into form by the first rays of the sun. The shadows of trees, rocks, and buildings are still somewhat softened by a large amount of diffused light along with direct sunlight. The shadows gradually shorten and become sharper and harsher as midday approaches. The sun passes the middle of its course; the shadows grow longer. With the passage of time, the shadows become less harsh and increase in length. The process has reversed since noon, and we gradually approach a condition similar to dawn. Sunset, which is concerned with color more than shadows, produces an ever changing display. After sunset, when the twilight shadows fall, objects seem to become enveloped in shadows until the moon rises in a clear sky to mark these great shadows with a few bright high-lights. The outlines of buildings and trees are well defined in the moonlight, but details are still lost in shadow. Evening shadows remind one of the end of *Hippolytus*. The dying Hippolytus is borne upon the stage by his companions as the last touch of color from a glorious sunset disappears from the sky. The twi-

light shadows lengthen into blackness, while the chorus mourns his unhappy end. As Hippolytus breathes his last in the arms of his father, the moon rises sufficiently to light the faces of the two men and then it steals behind a cloud to leave the stage is almost complete darkness when the curtain slowly falls. Thus light and shadow are found in infinite variety of pattern and mass in nature, and it is the problem of the lighting artist and the electrician to complete a scenic design by selecting those elements from nature which can be suggested by the apparatus and methods of stage lighting.

3. Importance of Shadows

Indeed, shade or shadows have been such an important, such an indispensable element in the *mise en scene* ever since the ritualistic origin of the drama, that we find evidence of shadow in the first records of the Oriental theatre long before artificial lighting was imagined. The actor's shadow was apparently his property man, draped in loose black garments, who followed the actor about the stage continually. But now, when we almost always use artificial lighting, shadows are produced for natural, artistic, emotional, and decorative purposes. Natural shadows are necessarily a part of formative lighting (Ch. I) to give the actor a more life-like appearance, and to give objects three dimensions, shadows are used artistically to balance masses of light in the stage picture and to keep the unimportant in the background. The emotional value of shadow is in its expression of mood and atmosphere, usually that of apprehension, fear, or death. Shadows of trees and objects of many shapes are cast upon walls and floor for decoration. For these purposes shade and shadow are equal in importance to light itself.

4. Light and Shade in Poetry

This statement of the high place of shade in stage lighting is substantiated by evidence of the prominent place of shade as wall as light in many, if not in all, great arts. In the component arts of the *Inscenierung* of the drama, examples of contrast in light and shade are easily found. In dramatic poetry one can hardly turn a page without seeing them, and in Greek drama, which is still our standard after a test of more than two thousand years, are found some of the most beautiful examples. Since the most powerful tragedy had to be produced in the glaring sun, the Greeks were dependent almost entirely on the poetry itself for the contrast of light and shade. Examples abound in the poetry of all ages.

. . . . Could I but bring thee from the shades of night
Again to view this golden light. . . .

Alcestis—Euripides.

. . . . Yet from those flames
No light, but rather darkness visible
Served only to discover sights of woe,
Regions of sorrow, doleful shades, where peace
And rest can never dwell. . . .

Paradise Lost—Milton.

Joyfully under him and free I played,
Basked in his shine and wantoned in his shade.

Don Carlos—Otway.

5. Light and Shade in Music

In music there is an effective contrast in light and shade in Wagner's *Die Walküre.* When Woton places Brünhilde on the rock and calls upon the god of the fire-glow to encircle the rock

with fire, the transition from shade to light is made by introducing the harp, then the bells, the triangle, and the cymbals while the flickering flames break into full brilliancy. In both the first and last acts of the opera, *Iris* by Mascagni, the music indicates the change from night to day. When the curtain rises, the stage is in complete darkness, and the music begins with the string basses. As dawn approaches, the other strings follow with wood winds, and then, as the sun rises, the horns and the trombones are heard. Finally, with the full brilliancy of daylight the shrill blare of the trumpets is added, and more trumpets on the stage behind the scene augment the dazzling effect. Thus, in music effects of light and shade are produced which can be coordinated with stage lighting.

6. Light and Shade in Painting

Likewise, light and shade have been of supreme importance in the evolution of painting. Every master of the brush knows well those principles which guide the eye to the center of interest and keep the subordinate in its place. Light and shade open the flatness of the canvas into three dimensions; they bestow true form upon the painted objects. Furthermore, by depth and sharpness of shadows the artist differentiates a cloudy day from one of bright sunlight. Of the great artists, Rembrandt is usually cited as preeminent in the use of light and shade. Whistler, also, is noted in this respect.

7. Light and Shade in Sculpture

Light is a master sculptor, and sculpture is almost entirely an art of light and shade. The sculptor chisels a contour, but light-

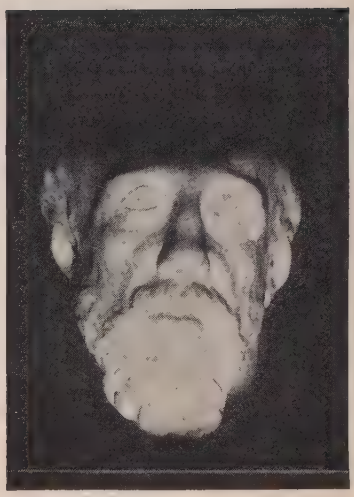
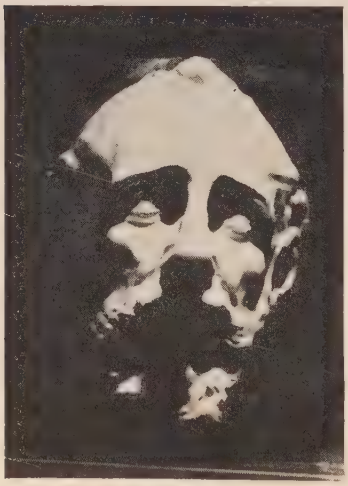
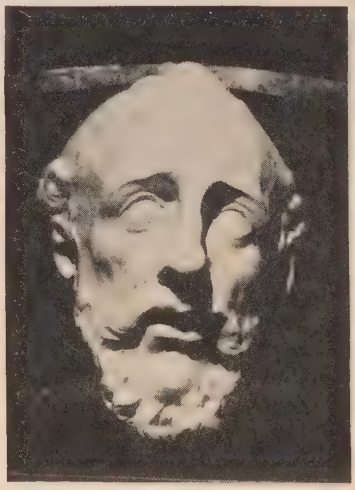
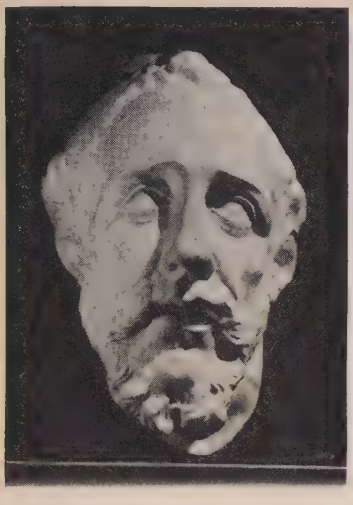


Fig. 36. (a) A face lighted by general illumination from all directions. Notice, flat effect of the shadowless face.
(b) A face lighted by footlights alone. Shadows are reversed causing a distorted expression.





(c) A face lighted by specific illumination, a spotlight, with no general illumination. The contrast between light and shade are excessive, and the head is directly under the source.
(d) A fairly well illuminated face on which both general and specific illumination are used, the contrast is a little too great. More general illumination from the observer's right will improve it.



(e) A well lighted face with a good balance between the two kinds of illumination. (f) A face lighted by a floodlight from one side only, the left side of the face is in shade, but there are no shadows; so the right side of the face is perfectly flat.

ing really models it. He cannot even fix an expression since it varies with the lighting and the shadows. Accordingly, the sculptor chisels for effects of light and shade, knowing the direction and the nature of the light which will fall upon his finished work. The statue of Lincoln in the Lincoln Memorial in Washington illustrates this point. When it was set up, the light intensity from below was greater than that above. This removed all of the shadows intended by the sculptor and gave the face of the statue a frightened expression. A lighting system has recently been designed which will maintain a greater intensity above, regardless of the intensity of the sunlight below. This lighting will cast those shadows intended by the sculptor to give the face that expression of repose and dignity characteristic of Abraham Lincoln. Examples of light on sculpture are shown in Figure 36.

8. Applying Light and Shade to the Theatre

The above paragraphs of this chapter are a brief résumé of the fundamental importance of light and shade in nature and those arts that are so firmly rooted in theatre practice. These are the principles which every artist knows well and uses unconsciously. They are a part of him. These are the principles which every Little Theatre worker must use as a part of his equipment for solving the artistic problems of play production. With mere illumination on the stage these arts which we have discussed are dissociated entities. With formative light, in which light and shade are inseparable, these elements become a single living creation, the *Iscenierung*. In demanding that all shadows be "killed," many directors have not only placed false emphasis on the arts which are only a part of the environment but also have reduced the art of lighting to the single function, illuminating the actor and his environment. The cold and brilliant flatness which results from this procedure, not only violates every principle of the art of lighting but often is painful to the eyes that view the result from the front.

9. The Actor

In discussing the use of light and shade for beauty, let us consider the performance of a play to be a living picture. First, light, the master sculptor, takes for the medium of its art the actor with his natural characteristics, changed perhaps by make-up and costume; it raises to prominence the high lights, and cuts deep the furrows of shadow to produce that life-like appearance which makes the actor look his best. When all of the shadows

have been destroyed and there is only light, the actor appears flat and two dimensional; when the shadows are natural, he immediately comes to life in three dimensions (Fig. 36). The director designs his stage pictures by a variety of groupings as the center of interest changes from one part of the stage to another, from one group to another. As in painting, light directs attention to the center of interest, and shadow leaves the unimportant in its place. Balance in the stage picture is maintained by different intensities of light at different places and on different groups of players.

10. The Environment

In such a fashion, light and shadow descend upon the inanimate objects of the setting and give them their proper degrees of prominence. Like the actors, the properties and other decorative objects upon the stage are given three dimensions, true form, by light and shade. Unlike their performance under brilliant general illumination, the properties and scenery, when shade and shadows have their place, do not play in front of the actors and distract the audience from the vital part of the performance. Brilliant general illumination lights actor, scenery, draperies, and properties equally, and thus attracts attention to detail in the elements of the setting as much as to the actors. This practice is unfair not only to the setting, because the general effect is spoiled by emphasis on detail, but also to the actor to whom the attention should be drawn. A prominent scenic designer has said that, when the curtain rises, the setting should call attention to itself for a few minutes only. It should then sink into the background and attract no further attention. If the gen-

eral illumination is of low intensity and the acting areas are illuminated by spotlights with a higher degree of intensity, we have light and shade which keep the background subordinate. Figures 44, 45, and 47, are examples of well lighted interiors.

11. Exteriors

In exterior scenes, general illumination used alone makes the illusion of distance impossible. Consider, for example, a grove of trees so lighted. The trunks of the trees will be uniformly lighted with no high lights and shadows, and the foliage will be as bright and flat as the trunks. Furthermore, all of the trees on stage, up-stage and down, will be uniformly lighted, since general illumination cannot be confined to a definite area. The trees intended to appear to be two hundred yards away will seem as near as those closest to the footlights. To light this scene properly with variations of light and shade we shall not cast out this general illumination entirely, but we shall dim it to very low intensity. In addition we shall add a number of spotlights to cover different areas, and if this is a scene in sunlight, we shall have the sunlight indicated by units of higher intensity directed from one side. All of the spots must be focused and directed to produce pools and paths of light among areas of shadow, and the spots down-stage must be of greater intensity than those up-stage. Thus, the illusion of perspective and great distance can be created.

12. Flat Scenery

As recently as forty years ago the sort of scenery which held the stage consisted chiefly of a drop curtain painted with all of

the splendor a scenic artist could muster. The actor could not play in this setting; he played in front of it and resembled a small spectator pacing before a folio edition of an easel-painting. Shadows were painted upon this drop with no thought of the stage lighting which was to illuminate the scene. In fact no thought was required, for in those days, when such was considered good scenic design, mere illumination was all that was known of lighting. Perhaps this digression seems to belong in an historical sketch and to be somewhat pointless in a modern discussion, but we still see these drops and strange botanical specimens called wood wings and foliage borders today in nearly every school and college auditorium, where scenic studios have sneaked them in on contracts for stage equipment. Furthermore, stock companies throughout the country are setting these tawdry relics and museum pieces regularly before a gullible public that wants something better but does not know how to get it. Lighting a stage decked with such stuff is a compromising and almost hopeless task with our modern methods, for the light which we find necessary for other reasons will rarely conform to the painted shadows, and the natural shadows cast by light will be entirely out of consonance with the painted ones. Some have tried to combine formative lighting with the scenic art of the easel painting and the photographic school, but it is wasted effort. Perhaps the best way is to light such drops with general illumination of medium intensity and try to keep the business well down-stage so that the formative lighting on the actors will not fall upon the drop. Any specific illumination by spotlights will make the drop look ridiculous. Unfortunately, nothing can be done to produce the illusion of three dimensions; a painted drop will look flat and lifeless to the bitter end. Scenery should be plastic, and shadows should be cast by light, not by paint.

13. Problems on Different Stages

While nearly all American theatres including Little Theatres, contain the "peep hole" or picture frame stage, Little Theatre groups often produce plays under conditions in which the problems of lighting are similar to those on the architectural stage, the sculptural stage, and the space stage. It will be obvious, after further discussion, that the lighting problems for outdoor productions, productions in buildings without prosceniums, and productions with little or no scenery are akin to lighting problems on the stages just mentioned. Even where there are prosceniums, they are occasionally ignored for a Shakespearean or Restoration play produced in a permanent set. Here again we are lighting for an approximation of the architectural stage.

14. The Architectural Stage

Jacques Copeau's Theatre du Vieux Colombier in Paris exemplifies the modern formal or architectural stage which is built permanently at one end of the auditorium with no proscenium wall. In Copeau's theatre there is a balcony at the back of the stage with a large archway below. Some few changes can be made in this permanent setting but little or no change is made during a performance. In such a place the first problem to consider is that of hiding places for the lighting equipment. Spots can be concealed in convenient places in the ceiling, walls, balcony and lighting fixtures throughout the auditorium. Because it is impracticable to change the focus or direction of the spotlights during a performance, a larger number of spotlights than are needed with a proscenium may be necessary for elaborate light changes. Additional demands are made upon light and shade because there are no scene changes. Let us consider what

might be required of light on such a stage. Before the audience appears the auditorium and stage are dimly lighted by a soft glow. Light enters with the first actor, and, as others appear, the narrow shaft is enlarged to include a group. Thus light attracts attention to a definite part of the stage, which is a scene in itself, while that part of the stage not in use is in semi-darkness. To change the scene, light moves to a different part of the stage. High-lights are changed to shadows and shadows to high-lights. New objects appear and old ones disappear. In an instant the scene is completely changed by light and shade.

15. The Sculptural Stage

Perhaps our most striking example of the sculptural stage is the one suggested in the set of designs for *The Divine Comedy* created in model by Norman-Bel Geddes.[1] The general shape of his stage is circular (there is no proscenium, of course), and the audience sits in a semi-circle facing the stage. The stage is composed entirely of steps. The following excerpt from his description of the lighting will give some idea of the magnitude of the lighting problem on such a stage.

"Another important element in the project is illumination. The lighting varies every moment of the performance. . . . Artificial smoke is utilized to accentuate the rays and increase the feeling of space . . . the area covered by the light increases until the entire stage and auditorium are included in the whirling nebulous glow. . . . The light comes from all sides, flattening all relief and eliminating shadows to give a feeling as thin, filmy and as much that of unending space as possible. . . . Simultaneously the light is directed into the audience, dazzling

[1] Norman-Bel Geddes, "A Project for the Theatrical Presentation of the Divine Comedy"—Theatre Arts 1927.

them for an instant. Then total darkness. Gradually a soft glow returns over the auditorium. The place where the stage was is a dark void. . . ." Mr. Geddes expresses great confidence in stage lighting, and the photographs of his lighted model show that his confidence is not misplaced. In these designs one will find some of the finest examples of the use of light and shade in stage lighting that have ever been published. Such beauty of pattern and mass of light and shadow is rarely seen.

16. The Space Stage

A space stage may be behind a proscenium, or it may not. The essential thing is that it be devoid of all conventional scenery. For background, a black velvet cyclorama or an unlighted sky dome serves best. Vignette settings, consisting of a screen to suggest the wall of a city, or two flats to suggest the corner of a room, sometimes appear on the space stage, but more often light alone is the setting. An actor appears out of vast blackness and steps into a pool of light limited by neither time nor space. He plays in light, and his background is shadow. Appia's later designs suggest the severity and simplicity of the space stage. One of his scenes from *Hamlet* consists of two floor levels connected by a few steps; light was to do the rest. The trees of his forests are light, and the foliage is a pattern in shadow.

On these three types of stages just described and discussed in their relationship to light and shade we have seen that simplifying scenery and reducing scene changes places new and greater demands upon stage lighting, and greater opportunity for imagination in lighting design is offered. Here the electrician must be more ingenious, and the lighting artist must have greater vision.

17. Symbolism and the Emotional Effects of Shadows

Light is really unexplored as a dramatic medium, a medium of expression in the theatre, but darkness and shadow are such well-known symbols in every-day life that they can easily be adapted to the stage. We speak of shady transactions and shadows of the past, and the dead or spirits of the dead are sometimes called shades. Since people are familiar with the symbolism of shade and shadows, we can use them for mood and atmosphere on the stage.

A shadow slinking along a wall is more expressive of fear and danger than the figure itself. And, if this shadow is increased in size by placing the light source below, the ominous and evil foreboding expression of the character is definitely magnified. For instance, the large shadows of the Bishareens cast in this way on the wall of the street scene in Dunsany's *If,* do much in foreshadowing the mischief they intend to work upon the Shereef. Sometimes a religious motif can be expressed by the shadow of a Buddha in a Chinese drama, or the shadow of a cross may subtly suggest the pervading religious atmosphere of a play of old Mexico. Instead of having an actor appear in the rôle of a ghost, one might project a shadow of the actor on a wall or curtain. As one works on plays requiring such effects, many similar examples present themselves which are valuable for reinforcing the dramatist's intent.

18. Shadow Decoration

Closely associated with the use of shadow for atmosphere and symbolism is its use for decoration, for pattern and design. One designer was faced with the problem of getting a pyramid on

the stage. He finally solved the problem by casting the shadow of one across the setting. Constructing a large tree with foliage and handling it on the stage is a difficult task, but casting a shadow of the tree is comparatively simple. Shadows can be cast in two ways; with an effect machine (or the equivalent lens system; see Ch. III, Sect. 6) or with spotlights. The shadows which are best cast by spotlight are those of natural objects exposed to view in a set, but for actual shadow decorations projected on a surface, a Linnebach projector (Ch. IV, Sect. 11) or an effect machine (Ch. IV, Sect. 10) is far superior. As explained in the section on effect machines all sorts of shapes can be cut from cardboard to be used as slides and projected on a surface for decorative and emotional effects of shadows. These shadow shapes are not only interesting and very effective, but they also save expense and time. Notice the problems involved in getting these effects, discussed in the sections mentioned above. Figure 46 is an excellent example of an effect projected on the cyclorama.

Shadow trees are particularly applicable to exterior scenes in which the outside wall or walls of buildings are visible. In a Greek play like the *Antigone* of Sophocles or the *Hippolytus* of Euripides the outside walls of a palace stand almost throughout the entire performance, and some unobtrusive decoration is needed to make the wall of stone less cold and bare. The design in Figure 38 was made to illustrate this idea of shadow decoration. If there are vines placed on a wall, the light can be directed in a way which will cast shadows of the leaves. Sometimes a small tree is placed in front of a house in an exterior. If the general illumination is low enough in intensity, a spotlight will cast a pleasing shadow of the tree upon the house. General illumination must be maintained at low intensity in all of these

cases, for it is easy to spoil these desirable and effective shadows used for decoration. It is better to keep the shadows well upstage behind the principal areas of stage business, so that the lighting on the acting areas will serve its purpose without conflicting with the light for decorative purposes. If the shadows

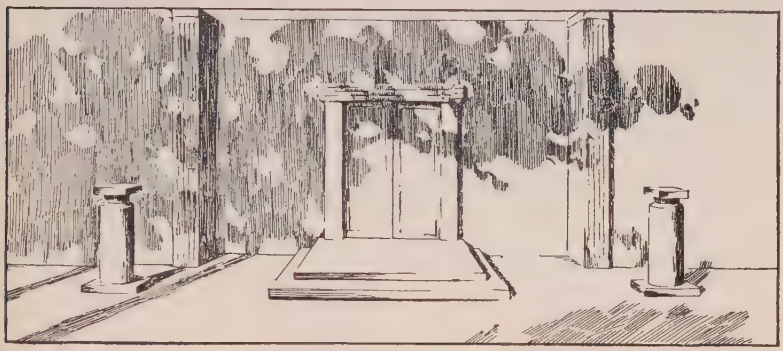


Fig. 38

A design for the *Hippolytus* of Euripides to illustrate shadow decoration.

are too sharp or in excessive contrast, a flood of low intensity from the opposite side, or the general illumination, will properly diminish this contrast.

In interiors there is less opportunity for shadow decoration, but a few suggestions might well be made. The shadows of small objects like bits of statuary or other ornaments might be pleasing under certain circumstances. A grating in a window will cast a similar shadow pattern upon the opposite wall or upon the floor if the source of light is outside of the window (see Fig. 47). One must be careful, however, to use good taste and a sense of design in the use of shadows as in any decorative medium. Abnormally large shadows will appear grotesque and will distract from the play.

19. Multiple Shadows

When two or more sources of light are used (it is almost always necessary to use more), the danger of double, triple, or even multiple shadows is imminent. The footlight shadows which have been censured already, constitute a horrible example of multiple shadows.[2] If we have general illumination of low intensity from a border or floods and specific illumination from six or eight spotlights covering the acting areas from different angles, multiple shadows of the actors and even properties are almost certain to follow. These shadows may be unimportant if they fall upon the floor only, but they may fall upon walls, or properties, or may throw an actor's face into obscurity just when he is saying a very important line or expressing intense emotion.

Thus it is the problem of the lighting artist or designer to handle a large number of sources. He must have sufficient general illumination to prevent excessive contrasts in light and shade, yet he must produce decorative shadows, and differences in intensity for the sake of variety, along with sufficient illumination to allow the audience to see facial expressions at all times. Co-ordinating these several elements in the lighting designs is no sinecure. First, the spotlights in front of the proscenium should be high enough and near enough to the proscenium to cast very short shadows, so that they will not fall on walls upstage; and the spotlights should be focused and controlled in three groups, one for stage-left, one for the center, and one for stage-right.[3] Dividing the control will allow the attention of the audience to be attracted to a particular area without keeping the down-stage area brightly lighted from stage-left to stage-

[2] This is discussed at length in Chapter IV, Section 2.

[3] This, of course, depends largely on how the stage business is planned.

right. The spotlights for the acting areas up-stage do not have to be of the same intensity all of the time, but, as the action moves from one area to another, light can follow it by being gradually decreased in intensity on one area and by being increased on another. In this way we are preventing multiple shadows by having only one intense source of specific lighting used at one time. If this is from the side, there may appear too much contrast between the lighting of the two sides of an actor's face. A floodlight or spotlight of lower intensity from the opposite side will correct this excessive contrast without spoiling the formative effect. Changing the source and the intensity as the dramatic action moves from one place to another not only prevents multiple shadows and guides the eye to the center of interest, but also produces a beautiful pictorial composition in light and shade. As explained in Chapter VIII, Section 13, taste, discretion, and care are quite necessary in such a procedure.

20. Conclusion

The intent in this chapter is not to lay down many definite rules but rather to impress upon the non-professional lighting artist the significance of light and shade so firmly that his work will continually show forth this knowledge. The suggestions scattered through the chapter will help to give him a starting point. Beyond this point, experience with the right perspective can lead to beautiful accomplishments. We must never forget, however, that beauty in lighting demands the creation of shade and shadow instead of the destruction of them. We have seen the conspicuous and consequental place of shade as well as light in several arts; and, when these arts are a part of play production, we have learned that the burden of bringing all of them

into a more intimate relationship is the peculiar function of light and shade. Then if shade be not forgotten in the use of light, the production of a play can be an artistic representation of life and a living work of art. "Without shadow there can be no light," said Appia. And now after a quarter of a century the stage is slowly beginning to realize this universal truth.

CHAPTER VII

LIGHT AND COLOR

1. Introduction

The subject of light and color is so vast and so intricate and at times so confused, that the non-professional artist often hesitates to attack it. To give one a thorough understanding of the subject would require the space of a volume equal in size to the present one at least. Obviously, a discussion of that depth and extent is neither wanted nor required by an elementary student of lighting. The subject of color in pigments has been discussed briefly in Part One, ChapterVI; so pigments will not be considered here except in their relationship to light. The terms used in discussing color in light are, unfortunately, somewhat different from those commonly used in discussing pigment, but the ones used here are the ones in general use by color physicists and leaders in the field of stage lighting. Much confusion in these terms will be prevented, if non-professionals will adopt terms in common usage in order that they may not only prevent confusion among themselves, but also that they may help in the present effort to bring color nomenclature out of its state of chaos. At present, leaders, both in science and art, are trying to agree on a common language of terms that will be easily understood.

2. The Spectrum

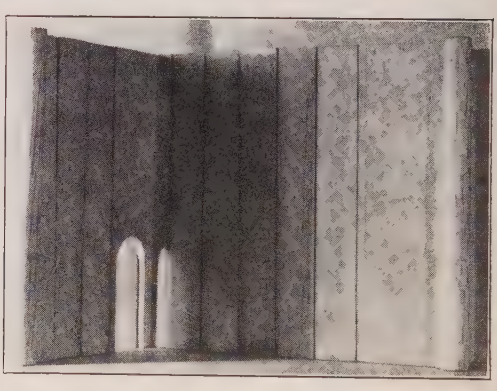
In Chapter III, Section 4 it was stated that light, passing through a piece of glass with oblique sides, such as a triangular

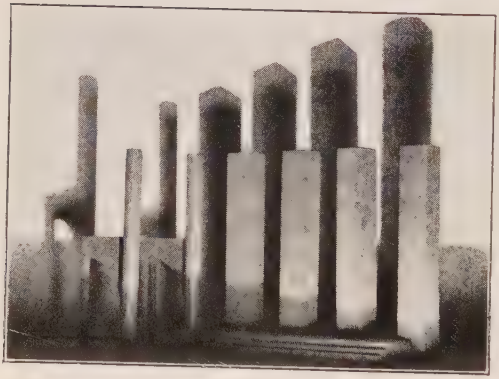
prism, is refracted, or bent away, from its original direction. When light is bent through a certain angle, it is separated into a number of bands of colored light called a spectrum. This proves that white light is not homogeneous but is a mixture of a number of hues which we usually designate as violet, blue, blue-green, green, yellow, orange, and red. While there are many other intermediate hues in the spectrum, these are the principal ones. The technical method of referring to a hue or any part of the spectrum is by wave-length, and it will be necessary from time to time to use the term wave-length. To make the present discussion seem simpler to those who are being introduced to this subject, the wave theory of the nature of light has been omitted both in Chapter III and in this chapter. Those who are interested in it are referred to any standard text book in physics. For purposes of this discussion, the reader can just accept the fact that the part of the spectrum which is visible to the eye lies between the wave-lengths .40 micron and .70 micron and that each hue lies between certain wave-lengths within the range .40–.70. For example, violet is between .40 and .425 micron. This material on wave-lengths of the hues is introduced to show that there is a more accurate way of designating a hue than merely calling it green. It might be anything from blue-green to yellow-green, but if we say green between .52 to .54 micron, one will know exactly which green is meant by looking at a color chart that is provided with a scale of wave-lengths. To designate a color completely, however, we need other terms.

3. Hue, Saturation, and Brightness

With the spectrum as a standard, it is possible to describe a color in terms of its *hue, saturation,* and *brightness.*

Two settings by Cleon Throckmorton for the Theatre Guild Production of DuBois and Dorothy Heyward's *Porgy*. The designs for the open court yard in Catfish Row and the interior of Crown's room were inspired by an actual place in Charleston, South Carolina.





A model of a general utility (unit) set designed and manufactured by Cleon Throckmorton which is capable of an infinite number of combinations and is suitable for setting a wide variety of scenes.

The *hue* of a color is determined by its place in the spectrum between certain wave-lengths. As a green was designated in Section 2, a hue of red can be designated as lying between .67 and .70 micron of wave-length.

Saturation [1] is the extent to which a hue is free from neutralization by its complement.[2] That is, a spectral hue is said to be 100 percent saturated. Accordingly, a *tint* of a hue is produced by adding less than an equal amount of its complement to the hue. The hue is then said to be unsaturated. For example, if 85 percent blue and 15 percent yellow are mixed, the result is a 70 percent saturated tint of blue.

Brightness [3] in general, depends upon intensity of illumination and coefficient of reflection (Ch. III, Sect. 1). Suppose, for example that a spotlight controlled by a dimmer, throws green illumination on a certain surface. The brightness of the illumination can be changed by dimming the spotlight, that is, changing the intensity of illumination. The *relative brightness* of different colored surfaces under white light is expressed as their coefficients of reflection. Hues lower in brightness than spectral hues are called *shades.*

With differences in saturation and brightness, thousands of tints and shades of each hue are possible, and there are well over a hundred hues. Then, by its position in the spectrum (hue), its freedom from neutralization (saturation), and its intensity of illumination and coefficient of reflection (brightness) it is possible to isolate a color, so that it will not be confused with another. This method of designation, however, does not take the place of adequate color nomenclature.

[1] Corresponding to "Intensity" in pigments (Part I, Chap. VI, Sect. 4).
[2] Complement is defined in Sect. 6.
[3] Corresponding to "value" in pigments (Part I, Ch. VI, Sect. 4).

4. Primary Colors—Mixture by Addition

Conversely to the refraction of white light into a number of hues, white light can be produced synthetically by mixing certain hues. This method of color mixture, called the additive method, consists of mixing equal parts of the spectral hues

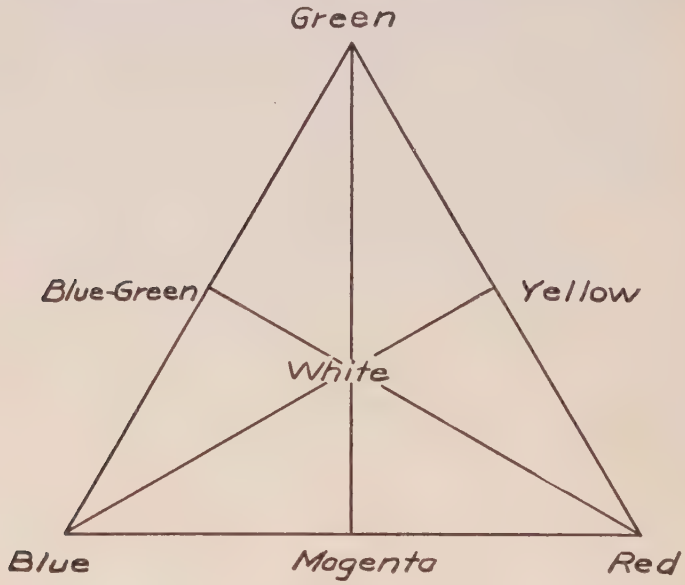


Fig. 39. The Color Triangle

Illustrating the additive method of color mixture.

(pure colors), blue, green, and red to produce white, or of mixing equal or unequal parts of two or all three of these to produce any desired hue. This additive method of color mixture is illustrated in Figure 39 by the well known color triangle. By mixing equal parts of blue and red, magenta is the result. Equal parts of red and green produce yellow, and equal parts of blue and green produce blue green. This primary blue is sometimes called vio-

let because it does border on violet, but physicists seem to agree on the term blue because violet is often confused with purple. Let us keep in mind that we have been discussing color in light only (not pigment), and that we are dealing with hues which correspond to those produced by passing white light through a

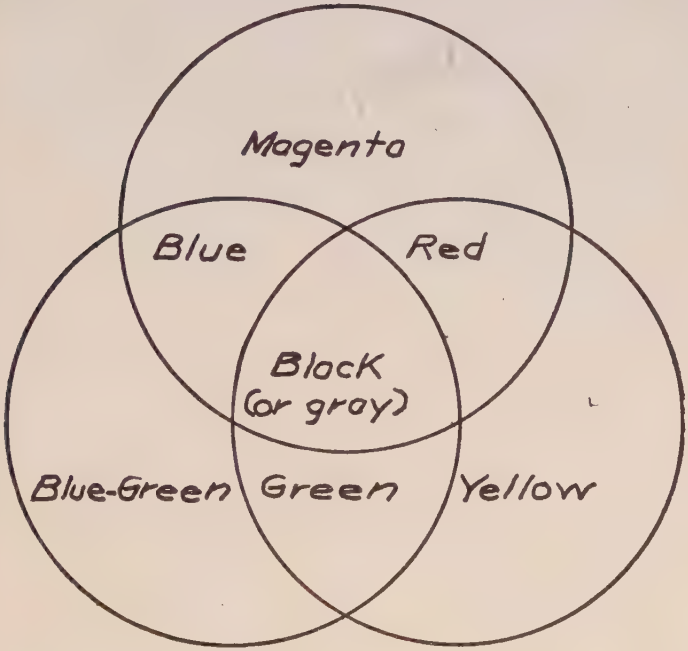


Fig. 40. Color Mixture by Subtraction

prism (hues of spectral purity). Hence the light primaries are blue, green, and red.

5. Light Secondaries

By mixing any two light primaries a secondary is produced. These secondaries, blue-green, magenta, and yellow appear at the mid-points of the legs of the color triangle. The way in

which they mix to produce the primaries is illustrated in Figure 40. This can be illustrated further by superimposing gelatine sheets explained in Section 7. Figure 40 might be considered as three discs of colored gelatine over a light source.

6. Complementary Hues

Two hues in light which, when mixed in equal parts, neutralize each other and produce white light are said to be complementary. From the color triangle (Fig. 39), it is evident that each primary is complementary to a secondary; in fact, any straight line which passes through the center of the triangle and terminates at two sides, or an angle and side, joins two complementary hues.

7. Applications in Stage Lighting

When a blue-green (a spectral hue) medium is placed in front of a spotlight, a blue-green light is produced by subtraction. That is, the blue-green medium has the ability to absorb all of the white except blue-green and allows the blue-green light to pass through. The blue-green medium absorbs its complementary—red. When a yellow medium is placed in front of a spotlight, yellow light passes through and the complementary, blue, is absorbed. When both yellow and blue-green are placed in front of the spotlight together, they subtract red and blue (their complementaries) allowing the remaining element of white light—green—to pass through. This is what we would expect by the subtractive method; blue-green mixed with yellow produces green (Fig. 40). This is valuable on the stage because one sometimes discovers at an inopportune time that he lacks a medium of a particular hue. By using these principles he is able to pro-

duce the desired hue by superimposing two other color media.

Transmission is closely related to reflection. A red pigment is red by virtue of its ability to reflect red light and to absorb its complement, blue-green.[4] A well know example of color mixture is that of coloring the edges of half a stack of cards red and the other half green. By placing them alternately so that each green is between two reds, they appear from a distance to be a shade of yellow. This principle is used in painting scenery by the well known *pointillage* and broken-color methods. Small spots of two or three hues are spattered in juxtaposition over an area. The resulting effect, one hue, when viewed from a distance, is produced according to the additive method of color mixture because this is really a light, not a pigment, mixture. Each hue is reflected and mixed with its neighbor before it reaches the eye; together they produce the sensation of a single color, the resulting hue of the mixture. Suppose an area is spattered with dots of blue and red and illuminated by white; at a distance the eye sees this as magenta. Thus a colored surface painted in broken color can duplicate any flat color, but at the same time it has a more interesting, vibrant appearance than a flat color because a flat color has a single coefficient of reflection while the elements in the broken color usually have different coefficients of reflection (Ch. III, Sect. 1). The hues resulting from this method of mixing are low in value (see terminology for pigment Part One, Chapter VI, Section 6) because reflected light is always less than incident light. Much of modern scenery is painted by this method.[5]

[4] This is considering that synthetic white light fell upon the red. Theoretically, in general, red absorbs all wave lengths but red, but actually, red pigments reflect other wave lengths.

[5] See Part I, Chapter VI, Section 13.

8. Colored Light on the Stage

Mr. Robert Edmund Jones, the eminent American scenic designer and director, told the writer some time ago that in the theatre he had seen only one instance of colored light which was entirely satisfactory. This color, he said, gave him an entirely different feeling, a satisfaction foreign and vastly superior to the color produced by the common gelatines, glass, and silks used in lighting the countless performances of his experience. Spectral hues such as he mentioned were produced in a London theatre by a large piece of apparatus, called the Klein Color Organ. This consisted of four sources of arc light, three sets of large glass prisms, and a number of shutters. The apparatus was controlled electrically by a keyboard similar to that of an organ. By "playing" upon this keyboard the colors could be mixed to produce any hue, shade, or tint. Although this is a very interesting piece of apparatus which might be applied to some peculiar spectacular performance or color display, it is obvious that such a large and intricate mechanism could do nothing to improve the application of the art and physics of color to play production as it is practiced at present. So far, attempts to adapt prismatic color to the stage have shown that the most beautiful of colors, those produced by the separation of white light are impracticable at the present time. Consequently, to produce colored light upon the stage we have to fall back upon the method in which light from an incandescent source is modified by passing through color media.

9. Color Media

As explained above, a color medium of spectral purity produces colored light by virtue of its ability to absorb all of the

white light except one spectral hue. Color media that are in common use on the stage are glass, gelatine, silk, lamp dips, and Transolene. Cellophane, a Du Pont product which can be adapted to stage use will be described later. These media should be judged according to their spectral purity, permanence of color, durability, cost, and availability in a variety of hues and tints.

10. Glass

Glass has been available in a few hues only, blue, green, red, amber, and perhaps a few others. These hues are available not only in sheet glass of any size but also in a number of standard shapes like roundels for border and footlight units,[6] 6″ squares, and individual cover caps for lamps. Even the bulbs of incandescent lamps are made in "natural" color; that is, the color is made in the glass. The "natural" color incandescent lamps cost several times as much as the lamps of clear glass. In fact, all colored glass is expensive. The fragility and expense of glass exclude it from use in the theatre in large sheets for flood lights, but it is common for border lights and footlights where it is not often handled. Colored glass of spectral purity (spectrally monochromatic) is rare and very expensive. That which approximates spectral purity, however, is not uncommon and is just as good for stage purposes. Mr. Monroe Pevear, who has worked on this problem for many years, has at last produced a "pot" glass, available in the additive primary colors, which is, for nearly all purposes, of spectral purity. The color in glass is nearly always permanent. Glass is gaining in favor and is apparently coming into common use for color lighting.

[6] See Chapter IV, Sections 2 and 3.

11. Silk

Silk may be used for the production of colored light either by reflection or by transmission. Some of the early experimental work in color lighting was carried on with reflecting surfaces of colored silk. It is more durable mechanically than any other medium, but it has the disadvantages of high cost, impermanence, low coefficient of reflection and transmission, and impurity. For special effects it can be dyed so that one color runs into another.

12. Lamp Dips

Lamp dips are transparent spirit-soluble dyes dissolved in some such solvent as amyl acetate or acetone. These are available in a variety of hues of varying degrees of spectral purity and permanence. The cost is moderate. To apply such a lamp dip to incandescent lamps, the lamps should be placed base up in a string of receptacles at a convenient height above the floor. The lamps should be lighted, so that they will be warm. With this preparation the dip can be applied easily with a small can which will slide over the bulb of the lamp far enough to completely submerge the bulb in the coloring matter. After the can is removed the lamp will dry in a few minutes if the lamp is lighted. Dipping lamps is really a make-shift method of obtaining colored light, but it will do if one has inherited the sort of borderlights and footlights requiring it. If one could afford it, natural color lamps or cover glasses would be better. The dip will last quite a long while on lamps of fifty watts or less if ventilation is good; on larger ones, however, it soon burns off.

Scenes from two productions by the Department of Drama, Carnegie Institute of Technology. Above: a setting by Lee Mitchell for Euripides' *Trojan Women,* staged by E. Martin Browne. Below: a setting by Frank Stout for *Dark Hours* by Don Marquis, staged by Chester Wallace.

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Two more interesting scenes from non-professional stages. Above: a setting by Alvyn Burtis for *Murder Sentence*, by J. Jefferson Farjeon, presented by The Circuit Theatre Association of the North Shore, Evanston, Ill. Below: a setting by Elmer Hall for Richard Whorf's *The Greatest Rogue*, produced by the Whorf Players, Provinceton, Mass.

13. Gelatine

The fort of gelatine sheets is in the low price, which is between 15 and 25 cents a sheet, and in its great variety of hues and tints. Gelatine media might be called the universal color media of the theatre and display because, although glass is gaining in popularity for borders and foots, gelatine holds its own for spotlights and floodlights. Gelatine is sold in sheets of about 20 x 22 inches and sometimes in smaller pieces. It appears in all degrees of spectral impurity and impermanency. There is little if any of spectral purity, and some of it fades in a few minutes after it is placed in front of a hot lamp. Its chief fault, other than its impurity, is its susceptibility to heat and humidity. In dry climates it breaks if touched, and in climates of high humidity it bulges in all directions while in the frames. Gelatine shrinks considerably on heating; so one must be careful to allow freedom for expansion in the color frames. If tightly confined, it splits.

To give the reader a rough idea of the degree of spectral purity of color media, the writer has made a qualitative spectral analysis of Transolene (see following section) which is very similar to gelatine and hardly distinguishable from new gelatine (Fig. 41). For example, in Figure 41 the diagram shows that dark red Transolene is almost a pure spectral red because only the red part of the spectrum shows. Dark amber shows red, orange, and yellow. We interpret this as indicating that red Transolene allows only red wave-lengths to pass through it and that the dark amber allows red, orange and yellow wave-lengths to pass through it.

14. Transolene

Transolene is a color medium which has recently appeared upon the market at about two or three times the price of gela-

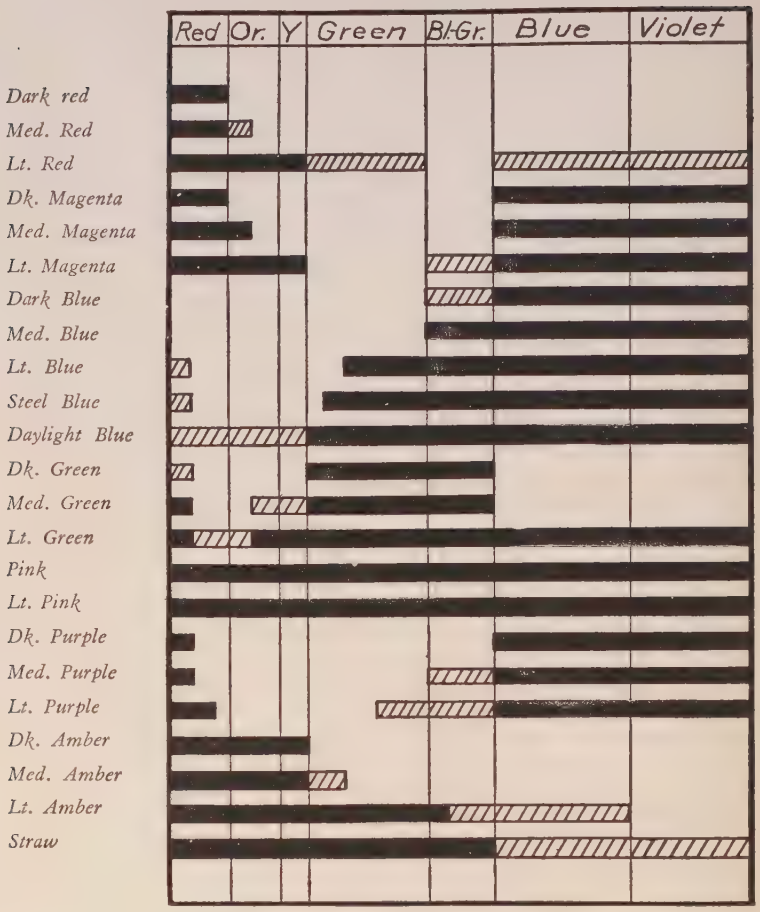

FIG. 41. AN APPROXIMATE QUALITATIVE SPECTRAL ANALYSIS

Of the color media called Transolene. Cross-hatched areas indicate about one-half brightness. Black areas indicate full brightness.

tine. It is superior to gelatine, however, in that it is unaffected by heat and moisture, and it can be twisted and buckled without splitting and cracking. These are decided advantages which

somewhat offset the high price. In range of hues and tints and in spectral purity (see Fig. 41) it closely resembles gelatine. Like gelatine it merely melts on exposure to fire.

15. Cellophane

Cellophane, a Du Pont product, resembles gelatine in many respects; but in strength and durability it is as good or better than Transolene. It is manufactured in only a few hues—red, blue, green, amber and violet at present. The sheets are about three times as large as those of gelatine, and the price is fifteen to twenty cents a sheet. Cellophane's chief disadvantage is that it is about as inflammable as paper. The writer has succeeded, however, in making it fireproof by leaving it in a concentrated solution of potassium alum for a few minutes.

16. Comparison

If Transolene can be brought down in price to fifteen or twenty cents a sheet, and if it can be made in the great variety of hues and tints of gelatine media it will certainly put gelatine out of the theatres. As far as the writer knows, Cellophane has not been offered to the stage, but it might be a serious competitor if it is offered in a great many hues and tints in a fireproof condition.

17. Color Media and Lighting Apparatus

With the color media mentioned above and the apparatus already discussed we are able to apply these principles of color mixture. If borderlights, striplights and footlights are wired in four circuits, one for red light, one for blue light, one for green light, and one white light, general illumination of any hue and

white can be produced with the three primaries. Tints can be produced by adding the complement to a hue; shades will result from a reduction in intensity; and additional white light can be had from the white circuit. Thus, the so-called four-circuit, three-color system is a direct application of the additive method of color mixture to general illumination for the stage, and it works with the old types of apparatus with dipped lamps almost as well as with modern compartment units employing glass and gelatine media. Although using our nearest approach to spectrally pure media produces more accurate results; these media transmit so little light (about 5 percent to 15 percent) that their inefficiency makes them undesirable in many cases. Many lighting artists and electricians prefer media less pure but with a higher coefficient of transmission.

For floodlights and spotlights, gelatine media and Transolene are in general use. It is often necessary to superimpose the media to get a certain hue. This is an application of the subtractive method of color mixture explained in Section 5. The additive method is sometimes applied when complementary spots are used. For instance, if one spotlight throws yellow light upon a plastic object and another throws blue light upon it, the high lights will appear in the original hue of the object because the blue and yellow light mix to produce white, but the shadows on one side will be blue and on the other, yellow. An object together with its shadows from several sources of colored light create a beautiful pattern in light, shade, and color.

One should not draw the conclusion that spectrally impure media are almost worthless. On the contrary, some of the most beautiful hues in colored gelatine are highly impure, and probably their beauty lies in the fact that a considerable range of the visible spectrum is transmitted by the media. When using color

media for spotlights we more often use tints than saturated hues because, although we want color, we want a relatively high intensity with it. From the discussion in this chapter and from the diagram in Figure 41, the reader will understand that a tint in color media allows a very much larger part of the spectrum to pass through it than a saturated hue allows. In other words it allows white light to pass through as well as colored light. This is the practicable means of getting greater intensity along with a desired hue.

The whole point in discussing the question of spectral purity in color media is not to lament the fact that they are impure but to show that the lighting artist and the electrician both need to know how impure media are. If they know their color media thoroughly, they will not be embarrassed by unexpected and unaccountable effects on scenery, costumes, and make-up.

18. Illuminants and Color

Before discussing the results of colored light upon scenery, costume, and make-up, it is necessary to consider briefly the effects of illuminants themselves, for they have a definite influence upon color as we use it upon the stage. So far, we have discussed transmission and reflection in connection with color without consideration of the nature of the illuminant with which we are working. The tungsten gas filled lamp used on the stage is the nearest approach to noon sunlight in the incandescent lamp family, but it is considerably deficient in violet, blue, and blue-green wave-lengths. Such light passing through a pure blue medium would not produce a blue of the same intensity and brilliancy that theoretical white light[7] would under the

[7] Noon sunlight is the nearest approach to theoretical white light.

same circumstances. This deficiency is not troublesome, however, because only one illuminant is used on the stage. We compare its effects with those of no other illuminant but accept it as having a certain definite and expected result. One thing, though, we must not overlook. As the tungsten gas filled lamp is dimmed, it becomes more and more deficient in violet, blue, and blue-green until just before it is "black out," orange and red wave-lengths are the only ones emitted. If, for example, a blue or green medium is impure to the extent of allowing red to be transmitted, the hue of the transmitted light will be considerably altered as the intensity of the lamp is reduced.

19. Costumes

In the study of costumes the effect of the illuminant is of considerable importance. Every woman knows that the hues, and tints of her costume have a very different appearance on the street in daylight from that under artificial light at night. Then, would it not be a breach of good judgment to choose costumes in daylight expecting them to look well upon the stage? That which will appear to be magenta in daylight, will lose almost all of the blue under an incandescent lamp. Losing its blue, it will appear to be red. This leads us to an indispensable element in costume making. When the costumes are dyed, the dye room should be illuminated with the dominant hues of light to be used in the play. Good training in the theory of color will be helpful in a general way, but nothing can take the place of actual experiment and practice. The fabric, its texture, its coefficient of reflection, as well as its hue, are of importance in determining the appearance of a costume under colored light.

Costumes are designed in the spirit and atmosphere of a play

and for color symbolism as well as for harmony in themselves. Costumes should have a higher degree of brightness than either the scenery or the properties, and the costumes of the more important characters should be brighter than the others. It is a function of lighting to emphasize this. A color is more brilliant when illuminated with its own hue or tints of this hue. On the other hand, if it is desired to neutralize a costume (make it look dull) light of its complementary will accomplish this. It was mentioned before that a costume can be made more beautiful by illuminating it with two complementary colors. The highlights will be unmodified because the complementary hues of the light will mix to produce white, but the shadows on one side will be of one hue and those on the other will be of another hue. It is assumed in this case that the spotlights are in front, overhead, and some distance apart. Costumes in well lighted scenes can be of saturated hues and shades, but in dimly lighted scenes such as moonlight or twilight scenes, tints are preferred. The reason is that saturated hues will not be in sufficient contrast to the background, and the character and his costume will be lost in a dimly lighted scene. The designer of costumes must, undoubtedly, know color in light as well as color in fabrics.

20. Scenery

In general, lighting should be kept off the scenery as much as possible. It has been said in the early chapters of this book that scenery should have little or no attention attracted to it. A function of light, therefore, is to prevent undue attention to the scenic environment and to draw this attention to the actor and the play. Even if no direct light falls upon the scenery, colored

light directed upon the acting areas will be reflected from the floor, properties, and actors and fall indirectly upon the scenery; this is perfectly evident because we could not see the scenery at all if no light fell upon it; so we know that colored light affects the appearance of scenery. Consequently, in the design of lighting for a play one must take into consideration the effects of colored light upon scenery.

Pointillage and broken color, being two important methods of applying pigments to scenery, should be considered further. It was said before that in the method of painting called broken color, the colors used will mix according to the additive method. The primaries blue, green, and red, put on a surface in juxtaposition and illuminated by unmodified white light will appear gray at a distance. Suppose the surface were illuminated by colored light. If both the pigments and the colored light were pure, blue light, being absorbed by green and red and reflected by the blue only, would make the whole surface a shade of blue. In this way it would be possible to make the scenery blue, green, or red by changing the color of the light. By mixing the light, numerous other hues could be produced upon the scenery. Patterns are sometimes painted in broken color and striking changes are effected by a change in the incident colored light. This sort of thing, however, is better adapted to spectacle than to drama. Coloring scenery with light for striking scene changes is very difficult to do in connection with other elements in the lighting design for a play. "Painting with light" is a high sounding phrase, but there are many impediments in the road to application in play production.

Draperies are sometimes used in Shakespeare and other romantic plays as well as impressionistic, and expressionistic plays with many scene changes. Natural monks cloth, which is a neu-

tral gray, takes light as well as any material for drapery; and velvet, too, is a beautiful material to illuminate. Few Little Theatres, however, can afford to buy velvet. Canton flannel is a cheap substitute which takes light well. Silks, rayon, and satin take light easily because of their sheen, and sateen looks like expensive silk when properly illuminated. Even coarse cotton material and canvas when dyed and skilfully lighted appear to be expensive draperies. Materials hung in folds for hangings, draperies, tents, and cycloramas present striking contrasts or pleasing harmonies by lighting the highlight folds with one color and the shadow folds with another. This color effect is achieved by two groups of floods from opposite directions.

If a scenic artist has studied light and color, he will know the degree of purity of his pigments and the degree of purity of the color media in use in his theatre. This general knowledge helps him to select pigments for his work and to predict the results. If he is wise, he will make charts indicating the effects of light upon the pigment he has in stock. In addition to this, as he paints the scenery, he will confirm his predictions from time to time by trying the colored light, intended for the production, upon the partly painted scenery. Neglecting to confirm predictions concerning details of setting is a common failing.

"Trick" scenery, that which changes entirely with change in light, is painted best in the light intended to fall upon it when it is finished. By changing the color of light the foliage of trees can be made to disappear. For example, trees, trunks, and limbs might be painted in a dark shade of purple on a blue background. The foliage could be added in blue-green. In white light the foliage will be seen clearly enough, but if this piece of scenery is illuminated with blue-green light of the proper hue, saturation, and brightness, the foliage will disappear. The

reason for the disappearance is that the blue background and blue-green foliage will reflect blue-green light to about the same extent. Since we cannot distinguish the foliage from the background, only the trunk and limbs can be seen. These will be blue. A drop is sometimes painted in some such way if a play demands summer in one scene and winter in another, and the result is convincing enough if only a part of the drop is seen through a window and door. Many such schemes have been worked out, but few are applicable to the mounting of plays. They belong rather to musical shows and revues.

The chief thing to remember in applying light and color to scenery as well as to costumes is to plan the production before starting to paint and dye. If it is necessary to have blue light, then it must be taken into consideration when the costumes are dyed and the scenery painted. Carefully laid plans and foresight along with a little knowledge of light and color will save endless grief.

21. Make-up

Make-up is actually a problem of the actor, not a problem of the technical department, but in the Little Theatre where the stagehand and the actor are in the same family, it is not considered an insult or breach of professional etiquette for the lighting artist to offer a suggestion about make-up. The lighting artist has studied the effect of light on pigment, and during dress rehearsal he has the opportunity of seeing the havoc played by his lighting on the average make-up applied by an non-professional actor.

In general, stage lighting adds yellow to natural complexion or to theatrical make-up and tends to make one look sallow and to take away the natural flush or coloring from pink skin.

Foundation grease paints are made accordingly with much more red in them than could be used in daylight. Unmodified stage light has the same effect on rouge. It makes it paler; so more rouge is required on the stage than on the street. When amber light is used, it does as unmodified light does, but it cuts out the red to a greater degree.

Blue light has the opposite effect upon rouge. The red does not reflect blue light; so the actor who is heavily rouged appears in blue light to have black lips and a black spot on each cheek.

Red light is reflected almost as much by the foundation color as by the rouge so that the actor appears in red light to have no rouge.

Green light has a ghastly effect upon the face. It should be avoided unless that effect is intended.

Tints of light, such as pink, violet, steel or daylight blue, and straw are easy to make-up for; pink is a flattering hue if sufficient rouge is used, and a violet called *"surprise pink,"* or *"natural,"* is excellent for make-up.

These are simple suggestions that all experienced actors know, and the non-professional should soon learn them. The actor has to depend on others to tell him how the light affects his make-up under actual stage condition and the lighting artist and electrician should help him.

22. Color Symbolism

Color symbolism and the emotional effect of color are mentioned here because they are causing discussion inside the theatre as well as out. Psychologists have been experimenting and getting data on the subject; advertisers have been trying to discover the effect of color on the public; and within the theatre

some artists and directors are using color for both symbols and emotional effects upon the audience. True, there is great divergence of opinion. Color does affect people very differently. For these reasons it has been considered of sufficient importance to mention some of the ideas and to present a list of the things which colors are said to symbolize and suggest. In some cases there is substantial agreement. Red, orange, and yellow are commonly called warm hues, and blue and green are said to be cool. A certain hue of red may suggest murder because blood is associated with murder. It also suggests anger perhaps, because a bull is angered by red. Green is generally agreed upon as suggesting envy under certain conditions.

Color on the stage is used primarily, of course, for beauty, but it has been discovered, sometimes by accident, that color affects an audience emotionally, even objectionably so at times. The atmosphere of a scene or complete play often suggests certain hues to an artist. To be sure, the same play probably suggests entirely different hues to another, and it is difficult to say which one is right. For example, red, orange, and yellow light might be used for the drinking scenes in *Twelfth Night* and *Henry IV*. Purple and red would suggest royalty and power in throne room scenes. Dagger-like shafts of red light for a murder scene in *Macbeth* are an obvious symbol.

This brings us to a clue to the mystery of the many conflicting ideas associated with various hues. Color can be used with so many other things which influence the impression it makes on an audience that one could never state arbitrarily that a hue symbolizes anything unless the circumstances are included. For example, form alone can change the emotional or symbolic value of a hue entirely. A dagger pattern of red light surrounding Macbeth when he says, "Is this a dagger, which I see before

me, the handle toward my hand?" could hardly suggest anything but Macbeth's state of mind as he plans to murder Duncan. On the other hand, a red costume for a king might well indicate royalty and power. To use color effectively for this purpose, one must always consider form, associated hues, and all of the surroundings that definitely influence the emotional and symbolic value that any hue may have.

A glance at the following list will show what a diversity of ideas are associated with a single hue. These have been taken from countless literary sources from all ages. They are included here as possible help in designing costumes, scenery, and lighting.

White is the symbol of light, purity, chastity, innocence, truth, modesty, peace, femininity, delicacy, sacrifice, and infirmity. White is cold, hard and cruel, and sometimes a symbol of mourning.

Black in many respects is opposed to white. It expresses gloom, darkness, woe, night, death, dread, mystery, horror, terror, evil, wickedness, crime, and mourning.

Gray, which is black diluted with white, loses some of the severity of black. Gray symbolizes humility, melancholy, resolution, solemnity, age, penance, sadness, and mature judgment. Of course, black, white, and gray are not colors, but they are used as such on the stage. Since they are symbolic, they are included here.

Red, classed as a warm hue, suggests blood, heat, fire, anger, hatred, cruelty, murder, tragedy, shame, and destruction. On the other hand it can symbolize, power, vigor, health, and passion.

Orange is a warm hue. It is a symbol of autumn, harvest, warmth, plenty, laughter, and contentment.

Yellow is also a warm hue. It suggests heat, liveliness, gaiety, gaudiness, and in some instances, cowardice, indecency, decay, deceit, and sickness.

Brown signifies autumn, harvest, plenty, warmth, contentment, and happiness.

Green suggests youth, vigor, spring, immaturity, contemplation, faith, immortality, peace, solitude, life, victory, and sometimes jealousy.

Blue symbolizes coldness, melancholy, the sky, the sea, heaven, hope, constancy, fidelity, serenity, generosity, intelligence, truth, spirituality, and aristocracy. Blue is opposed to its complement, yellow.

Violet signifies sadness, quietness, purity, love, sentimentality, royalty, and wealth.

Purple suggests royalty, heroic virtue, richness, and wealth.

23. Conclusion

This chapter, like all of the chapters on stage lighting in this volume, is a mere survey of the subject. The physics of color is a technical subject that is difficult even for advanced students. Authorities disagree, and their writings are difficult to understand. This brief outline, then, can do no more than give the reader some idea of the scope of the subject as it is related to stage lighting and offer him a few suggestions about the use of color on the stage. One should always remember in using any medium of expression in the theatre that all other elements are subordinate to the play and its interpreter. Color and light can easily call attention to themselves and distract the audience from that more important matter—the drama itself.

CHAPTER VIII

LIGHTING FOR INTERIORS

1. Summary of Preceding Chapters

In the preceding chapters we have considered the functions of stage lighting (Ch. I), the source of energy (Ch. II), the physics of light (Ch. III), the apparatus and equipment for producing and controlling illumination (Chs. IV and V), and the terms *light, shade,* and *color* (Chs. VI and VII). In short, we have stated a problem, described the instruments for its solution, and discussed the terms in which it is solved. There remains the solution of the problem—that is, the application of the functions by using the apparatus to produce light in terms of light, shade, and color for a specific purpose—the lighting of a play.

2. Outline of the Problem

In order to show how the functions are applied, we shall take as an example a typical setting in which the lighting problem is similar to that of a great many plays. For this example we shall make a light plot, or design, and show its relation to an electrician's cue sheet. In the previous chapters many suggestions have been made that will be useful in stage lighting in general, both for exteriors and interiors; and in Chapter VI, Section 11, the lighting of exteriors was discussed specifically. For that reason and because the majority of plays are set in interior settings, we shall choose an interior for discussion. The height of the

set is 12 feet and the proscenium opening is 24 feet wide and 18 feet high (Figs. 42 and 43).

3. General Suggestions for Interiors

We shall assume that the interior represents a living room in a comfortable dwelling house. Such a room should be decorated on the stage, as in an actual home, according to the principles of good interior decoration. There is a certain amount of selection and exaggeration necessary on the stage; but the two problems in decoration are similar.

In planning the decoration of the room, the interior decorator considers first the purpose to which the room will be put. The purpose also determines the lighting of the room; and the color, form, and size of the lighting units—such as bridge lamps, bracket lamps, table lamps, and other lighting fixtures—are considered to be a part of the decorative scheme of the room. Here are combined the aesthetic and the utilitarian. The lighting units are placed in their relationship to the furniture for work, reading, and amusement, and also for balance in space, line, mass, and color. At times color in decoration is balanced with color in light. These problems, of course, are largely the problems of the scenic designer; but they often concern the lighting artist as well.

The important similarity, which one should notice between interior lighting on and off the stage, is that there should be specific areas of relatively bright illumination placed throughout the room not haphazardly but in a definitely planned arrangement. Now if one stands at a distance and looks critically at this room, he sees that the lighting of the room is spotty; that is, there are bright spots or areas, and between these bright

spots and in the corners are dark holes. When this is true, some general illumination is needed to brighten the dark corners a bit and to make the bright areas seem to flow into each other more smoothly. Light amber and pink are suitable hues for the general illumination of rooms in the home; but we shall not go into the method of producing that effect because the methods are not similar to those of stage lighting.

Accordingly in lighting interiors on the stage, one wants to create the illusion, or to get the effect, of lighting for good interior decoration. Since the visible lighting units (bridge lamps, table lamps, etc., mentioned above) are almost entirely decoration on the stage and are not a vital element in the stage lighting, there will probably be fewer of them, and the lamp within each unit will serve merely to illuminate the shade. Accordingly, the wattage of the lamp in any visible lighting unit in an interior setting should be very low to prevent distraction and fatigue in the eyes of the audience. Bright bracket lamps on the walls are particularly annoying to the audience. One can accomplish function (e) Division II (Ch. I) by directing spotlights in such a way that part of the specific illumination appears to come from table lamps, bridge lamps, and similar units.

4. Divisions of the Problem

In accordance with these suggestions in Section 3, a light plot for an interior setting will be devised by considering the following elements in the problem: (1) the color of each kind of light, (2) lighting the stage areas according to stage business, (3) the placing of units, (4) direction of specific illumination, and (5) movement in lighting. The accomplishment of the functions will be pointed out from time to time.

5. The Setting

Let us assume that an interior box set (Part One, Ch. II, Sect. 5) has been designed for a modern comedy of manners. The walls have been painted in broken color (Ch.VII, Sect. 7); and the dominant hue is a green of low brightness suitable for large surfaces such as the walls of a living room. Our problem then, is to choose hues and intensities of light which will give this scenic environment its proper degree of prominence as an appropriate background or environment without calling attention to itself. A good general rule is to keep most of the light, especially that from the spotlights, away from the scenery. Obviously some light will and should fall directly or indirectly upon it, else it would be a black and undesirable void.

6. General Illumination

Since our setting is a box set, the ceiling will cut out some of the positions for hanging lighting units; but we can depend upon the border light (Ch. IV, Sect. 3), which hangs just below and in front of the ceiling, directly behind the teaser (Part One, Ch. II, Sect. 2). From this position the borderlight should produce a shadowless glow of general illumination upon the actors, floor, properties, and somewhat upon the scenery; thus funcion (a) [1] of general illumination is accomplished. If the borderlight to be used does not confine the light strictly enough, that is, if it throws light too high upon the walls, a funnel-like hood (Ch. IV, Sect. 1) can be attached to the front of the lighting unit to restrict the light. The intensity of the general illumination will be determined by experiment; it depends, of

[1] For all references to functions, see Chapter I.

course, upon the coefficient of reflection (Ch. III, Sect. 2) of the scenery and properties and upon the degree of intensity of the specific illumination from the spotlights which we shall use. Upon the relative degree of the intensities of these two kinds of illumination, the proper accomplishment of functions (b) and (c) Division I depends; the suggesting of natural phenomena will be limited in this case, however, to indicating the time of day by the color of the general illumination. This is an evening scene and the lighting must appear to be the artificial light of an ordinary living room. We shall choose a hue, then, which will indicate interior lighting, a hue of yellow-orange which in gelatine media is sometimes called a red-amber. This hue for the general illumination is choosen for two reasons. (1) The yellow-orange is a mixture of unequal parts of green and red; so when this light falls directly or indirectly upon the walls of the set, which are predominantly green, the green pigment by selective reflection will reflect some light, the green part, and absorb the red (Ch. VII, Sect. 20). In this way the walls remain as they were intended to look, but since the yellow-orange light has only a small amount of green in it, the setting will not appear too bright. In addition to its appropriateness for the scenery and the time of day the color of the general illumination is chosen for still another reason. (2) The color chosen, yellow-orange, having a considerable amount of red in it, will be suitable for the make-up. Yellow light (Ch. VII, Sect. 21) tends to make the complexion sallow, but yellow-orange light has a sufficient quantity of red to allow the application of the actor's usual foundation grease-paint and the customary rouge.

Thus general illumination, light and color, accomplishes its three functions (Ch. I) in this box set for both the actor and his environment; but the method of producing the color is yet to

be discussed. It can be done in three ways. (1) If the border light is wired in three or four circuits, so that blue, green, red, and clear (white) light can be produced, the exact hue of yellow-orange is easily obtained by setting the dimmers (Ch. VII, Sect. 4). (2) If one has no dimmers, or has only one circuit, or both, the color can be obtained by using part of the lamps dipped yellow-orange or by using half of the lamps dipped red and half of them dipped yellow or amber. (3) With a more modern border light one can use gelatine or glass of the proper hue (Ch. VII, Sects. 10 and 13) if one perfers this method.

7. Specific Illumination

In general, specific illumination should not fall upon the walls of a set; but there are exceptional cases in which it may fall partly upon the set in order to cover an important piece of stage business near a wall or to emphasize an object of special dramatic value. Because of its form-revealing nature—that is, its ability to produce highlights and shadows—the specific illumination from spotlights will throw the actors and the properties into relief. Thus function (a) of specific illumination is accomplished; but before we can place the spotlights for this purpose, we must study the stage-business of the play in rehearsal, in order to discover the areas where the actors gather for important scenes throughout the play. We must note not only these areas but also the relationship of the actors to each other and to the properties within each area. Having this information diagramed on paper and well in mind, the lighting artist and electrician can determine the positions, direction, length of throw,[2] and choice of units to use to light these areas,

[2] The length of throw as well as the spread of illumination, obviously, is a determining factor in choosing the size (wattage) of lamp necessary to produce sufficient illumination on an area.

as well as the form [3] of the light appropriate for the groupings in the areas.

8. Placement of Lighting Units

Figure 42 is a floor plan of the interior set to be lighted. Here the furniture positions are indicated, and the circular areas—the acting areas—are lighted by spotlights. The intent is to have specific illumination from two directions (where necessary), which will produce the formative effect by differences in intensity but which at the same time will light the actor in any position he assumes.

The area of light down-right, near the fireplace, is produced by a 1000-watt spotlight in the ceiling beam at position B; the area down-center is lighted by two spotlights in the same beam at A and C; the up-center area near the double doors is lighted by a 400-watt or 500-watt spotlight at E on the batten on which the borderlight is mounted or hung. The last area down left, is lighted by a 500-watt spotlight on the first border batten at F and a 1000-watt spotlight on the ceiling beam at D.

In lighting a set that has a ceiling, one often experiences difficulty in placing the lighting units in the cramped space between the ceiling and the teaser. It is obvious, no doubt, that the borderlight has to hang below and down-stage from the ceiling; and to mask the borderlight, the teaser [4] must be lowered somewhat (perhaps as much as two feet) below the ceiling height. The teaser must likewise mask the spotlights

[3] Form, as it is used here and elsewhere in Part Two of this volume, means the shape or distribution of illumination from a lighting unit. A narrow shaft is one form, for example, and a wide spread of illumination is another. Form is determined by the focus of the unit, the lens, reflector (Ch. III), a mask, flippers, soft-edge device and other accessories discussed in Chapter IV, Section 19.

[4] An inner proscenium frame which has thickness helps mask the lighting units and cuts down the distance between ceiling and lower edge of teaser.

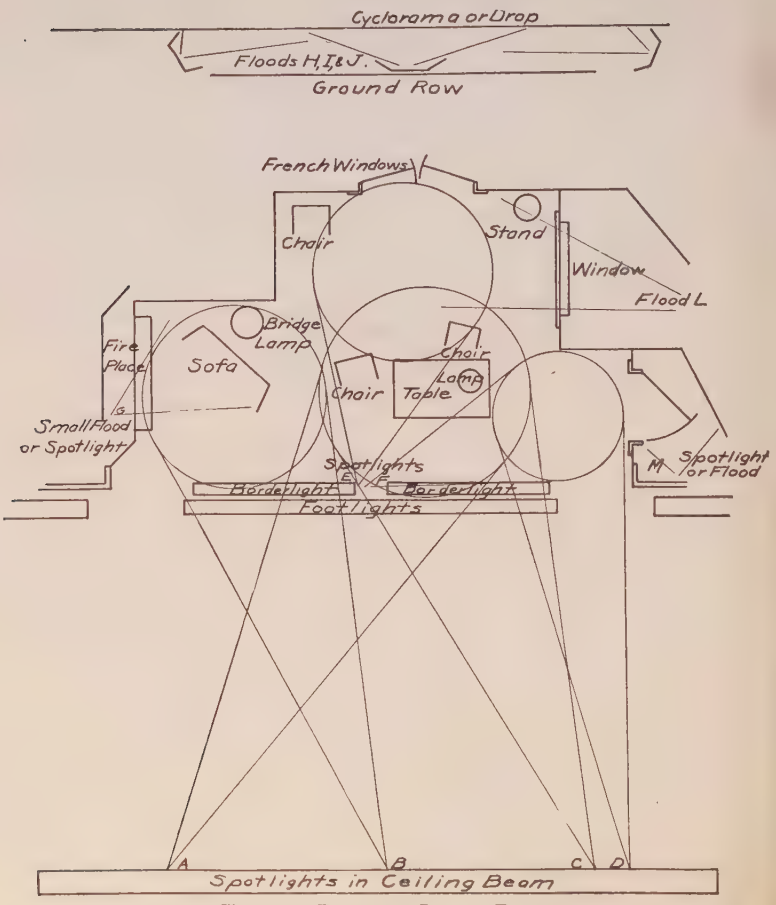

Fig. 42. Plan of Light Plot

which are mounted on the same batten with the border light (Fig. 43). Since lowering the teaser cuts down the height of the set, especially for the part of the audience seated in the balcony and the rear of the auditorium, the electrician must devise methods of hanging units which will require as little vertical space as possible between the ceiling and the lower edge of

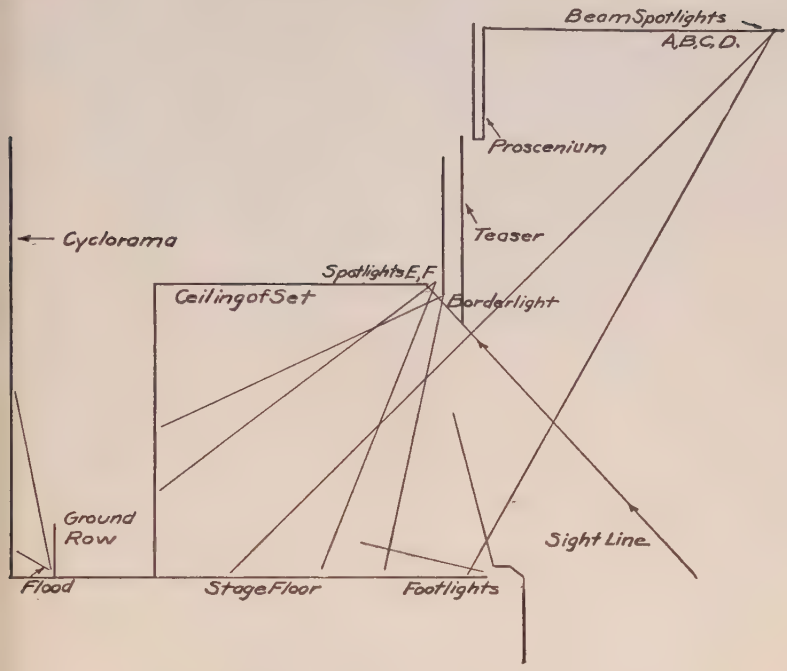

Fig. 43. Elevation of Light Plot

the teaser. If the borderlight is shorter than the width of the set and the borderlight batten, spotlights also can be mounted on this batten. It is preferable that the borderlight be in two sections, so that one or two spotlights can be placed between them on occasion.

Another excellent place for hanging units is on the vertical batten which is fastened on the back of a tormentor at each side of the stage near the proscenium (Fig. 19). The use of this position is better suited to lighting box sets of greater wall height and greater depth than to lighting under the conditions described in this chapter. The tormentor lights have to be mounted at a considerable height, so that the light may be directed from a

useful angle. When they are to be used, one must be sure that the set is designed to allow sufficient space between the downstage edge of the set and the tormentor (or the return of the inner proscenium frame as the case may be [Part One, Fig. 8]) for the light from these units to get into the acting area. The tormentor positions are very useful for lighting exteriors also.

This section gives one some idea of the problem of lighting units in places where space is limited. It is evident also from what has just been said that in designing scenery one must always know where the lighting units are to be mounted. Forgetting this, the designer may create an excellent piece of work; but without proper lighting, nobody will ever admire it or make use of it.

In addition to these units producing light within the set, there must be additional units for lighting around the set. Beginning at stage-right and going around the set to stage-left, we have first the fireplace. Here at G a small flood with a 100 to 250-watt lamp is needed on the floor outside. A baby spot with the hinged front turned back to make a small flood or an X-ray reflector with lamp and socket or a 12″ strip, or a 500-watt flood dimmed low will serve the purpose (Ch. IV, Sects. 4, 7, 8, and 14). The whole cyclorama or sky drop need not be illuminated, but only that part showing through the French windows. A 500-watt flood behind the ground row on the floor (at H), a 500-watt or 1000-watt olivette on a stand on each side (at I and J), and two hanging floods on a batten over head (at K) will light the backing properly, although there are many other ways of doing it. If moonlight is seen through the window up-left, a parabolic flood or a spotlight on a stand should be placed outside the window (L). For illuminating the backing at the door down-

left, a short strip (or a spotlight) above the doorway is satisfactory.

9. Color for Various Units

And last, but of considerable importance, is the determination of color for each of the units employed in specific illumination. Beginning at the fireplace again, one undoubtedly places a red amber or red medium over the small flood light (S). If this is a night scene, medium and dark blue media will be suitable for the cyclorama lights. For moonlight through the window up left, the flood or spot (L) should be provided with a moonlight blue, blue-green or a steel-blue gelatine. The backing strip in the doorway (M) down left may be amber.

For the specifically illuminated areas within the set, hues in color media should be used that will suit the costumes, make-up, properties, and setting. In addition, the color of the light must assist in the mood and atmosphere of the play. (Function C, Div. 2). Since this is a setting for comedy, most of the color should suggest warmth and happiness. Because the flood in the fireplace will produce red amber or red light on the groupings around the fireplace, the spotlight (B) covering this area might be provided with a straw (very pale amber) gelatine or a gelatine of a pale tint of violet (*surprise pink* for instance). The red flood of low intensity from one direction, and a brighter overhead source (the spotlight) from another direction will produce interesting highlights, shades, and shadows. The spotlights covering down center (A and C) and down left (D and F) might have pink or a very light red medium in one unit in each pair on an area, and very light amber for the others; and the up center area might be lighted with *frost* or just

a soft edge (Ch. IV, Sect. 19). Some new gelatine media manufactured by Towndsend called *flesh* and *natural* are well suited to the lighting of interiors. They make flesh appear in its natural coloring and require the minimum make-up; *surprise pink,* likewise has this tendency.

Thus, the specific lighting units are placed to accomplish the functions of specific illumination. (a) This light creates relief and reveals the true form of the actor and his environment. (b) Through its color and form it enhances the beauty of the setting by bringing out the intended color of the walls, the properties, and the appearance of the actor himself. (c) While in the example chosen, there may not be any unusual psychological and emotional value which can be made obvious with light, shade, and color, at least the color chosen will indicate warmth and pleasure. (If we had dealt with tragedy we could have easily chosen colder and more somber color.) If the director wants lighting to assist in building to a climax in the last act, less color or cooler hues may be used in the first act, and changes to warmer hues may be effected in the succeeding acts.

10. Direction

General illumination is not as easy to direct as specific illumination, but the vertical angle of the borderlight sections can be changed by shifting the chains around the batten (or by adjusting the clamps if it is so hung) to keep the light away from the walls—particularly the upper part of the walls.[5] The horizontal angles of the other units is indicated in Figure 42. It is obvious, of course, that these angles both vertical and horizontal, depend upon certain details of set structure and the

[5] A hood attached to the border light is helpful. (Ch. IV, Sect. 19.)

structural features of the stage. To even a greater degree they depend upon the stage business, which the lighting artist or electrician must study carefully in rehearsal. After the units are mounted in place, some adjustments and changes are almost always necessary in order to place a high light just where it is wanted, to light a face in a certain position, or to make a shadow fall in a definite place. The plan outlined here takes care of almost any stage business in the set in our example. In general, the shadows cast by the spotlights should be short, and they should fall upon the floor, not upon other actors and upon the walls. If a conspicuous shadow does fall upon a wall, it should be for a definite pictorial or emotional purpose. This leads to the question of vertical angle.

The vertical angle of the light from the spotlight determines the length of the shadows cast by the figure of the actor and the length of the shadows from hats and the features of the face. Then, too, the depth of the set, whether the playing is done very close to the curtain line or principally up-stage, and the distance from the proscenium wall to the spotlights in the ceiling of the auditorium—all must be considered in determining the vertical angle of light direction (Fig. 43).

11. Ceiling Beams and Substitutes

Here, no doubt, a reader who is working under somewhat trying conditions in an inadequately equipped Little Theatre building, adapted perhaps from a barn or dwelling house, will raise a good question. What shall I do if I have no opportunity for light directed from a position in front of the proscenium? It is quite true that the ideal way of getting light from this direction is to have false beams in the ceiling of the auditorium

designed for the sole purpose of concealing spotlights to light the acting areas from the front. In nearly every instance such beams are constructed when the theatre is built, but there are other ways of getting approximately the same direction of light. If those who raise the question will take a good look at the auditoriums in the buildings in which they produce plays, four out of five of them will see places where spotlights can be concealed or places which can be adapted to this purpose at small expense. The Berkeley Playhouse, Berkeley Calif., was an old church which had beams and rafters exposed. Here they mounted their spotlights at various places in front of the curtain line entirely exposed to view. Exposed as these units were, people did not think them objectionable, but masking them would not have been difficult. In school auditoriums that are really gymnasiums with a stage at one end, there is ample space for spotlights on the steel beams overhead. Here they would rarely, if ever, be noticed. Many auditoriums have some sort of lighting fixtures or chandeliers in which spotlights could be concealed. Suppose, on the other hand, that, apparently, there is no place in the auditorium for spotlights. There is still a solution of the lighting problem. The stage business must be kept up-stage far enough, so that spotlights hung just behind the teaser will properly light the actors at all times.

12. Intensity

The intensity of the various sources which we have discussed can hardly be determined unless all of the following items are known: the size of the set and the playing area; the coefficient of reflection of the reflecting surfaces, such as walls, floor, properties, and even costumes; the length of throw (distance from

source of light to area illuminated); the time of day to be suggested by light; the mood or atmosphere of the play. The ideal control for proper regulation of intensity is to have each unit separately controlled by a dimmer. If we have individual control of each of the units in our examples, different areas can be lighted with different degrees of intensity, as they should be, to gain variety in the lighting plan and to attract attention to the center of interest. Here we accomplish function (d) Division II. During the final adjustment of specific illumination in the different areas, some further adjustment of the intensity of the general illumination may be necessary in order to have just the right degrees of contrast between the two kinds of light and to pull the brighter areas together. Faced with a scene in which the relative intensities of these two kinds of light are ideal, one will get the sense of one area flowing into another. If the general illumination is too low, the effect of the bright areas is spotty. On the other hand, the bright general illumination mentioned often throughout these chapters, will flatten the total effect and make it monotonous. Because of its relationship with specific illumination, general illumination, when used intelligently, may be said to have a softening or modifying effect. In other words, one cannot say that the intensities of light in a certain play should be thus and so; to know the correct intensities takes experience, judgment, and trial under specific conditions.

13. Movement

In Section 12 the relationship of intensities in the different areas to the direction of attention to the center of interest (function d) was discussed. Those who know acting and directing know the principles of focus and counterfocus, and to them

it will be obvious that light can assist the actors in this problem. Since going into groupings and stage movement is not within the scope of this volume, it will suffice to say that by stage groupings and by several actors concentrating their attention on a single actor, the eyes of the audience are guided to the center of interest in the stage picture. In a similar way a painter guides the attention of the observer to the center of interest in his canvas, but on the stage during the course of a play or even an act there may, and doubtless will, be a series of successive centers of interest. Herein lies the opportunity for movement in light.

As the center of interest changes from a group about the fireplace down-right to the entrance of an actor through the doorway down-left, very gradually (and imperceptibly to the audience) the intensity down-right can be slightly reduced, and the intensity down-left increased. While the action proceeds in these two areas, the intensity in that most formidable area, down-center, is somewhat reduced. Meanwhile up-center is the most dim of all the areas, but when the chauffeur bursts through the doors up-center to announce to the fond parent that the heroine has eloped with the deep-dyed villain, the chauffeur certainly should have his entrance built up somewhat by a carefully timed and gradually increased degree of specific illumination in his area.

One must not get the idea, however, that this sort of movement in light can be accomplished by allowing a sleepy electrician to give a dimmer handle a kick as he sees an actor go through a door. That sort of movement is more objectionable than keeping the intensity static throughout a whole act or even a whole play. Some plays, of course, are better suited to movement than others. Plays detached from present day reality are better suited to having the center of interest emphasized by means of

light than are types of contemporary comedy. In doing anything in lighting, one must always keep in mind that any effect which distracts the attention of the audience from the play and the actor who is interpreting it, and calls attention to itself except for a definite dramatic purpose, is violating the best principles of play production.

14. Footlights

The reader, if he is still devoted to footlights, may have wondered whether they have been forgotten. Not at all, but here they are considered last because they are least important of the sources of light which have been used in the present example. If, after all of the other sources have been carefully adjusted to suit the demands of production, the director or lighting artist thinks that the facial shadows are a little heavy when the actors are far down-stage, the footlights may be increased in intensity from "black out" to a very low intensity which will soften shadows such as those in eye sockets, below nose, and under chin (Fig. 36). By all means, however, one should avoid the evils of bright footlights shown in Figure 36 and of the multiple shadows discussed in Chapter IV, Section 2.

15. The Various Elements

It is evident in this example that there is considerable opportunity for variety in arrangement of the lighting units and yet there are definite limitations caused by the set and the structural features of a stage. Obviously the size of the stage, its height, the height of the auditorium ceiling, the possibility of hanging spotlights in the auditorium ceiling and their position

in relation to the stage, the number of spotlights and other equipment available, and the use of a cyclorama or a drop—all enter into this problem. There is, however, a definite best solution with a given set of conditions, and it is the problem of the non-professional worker to find the best solution.

The real value of this example is not to be found in the idea that a certain type of spotlight with a certain lamp and definite color medium should be mounted in a specific place. Obviously an example cannot be that dogmatic. The value of the example lies rather in its procedure which is flexible and adaptable to many conditions and a great many plays. This procedure, which in its essentials is followed by many lighting experts, grows out of the point of view explained in this book. Stated succinctly it is this: two kinds of illumination—specific illumination to create formative lighting for the acting areas, and general illumination to reduce the excessive contrast and pull those areas together and to illuminate the set somewhat—are necessary in general to light the production of a play properly. To make these two kinds of illumination harmonize in order to create artistic lighting, one employs light, shade, color, form, intensity, and movement. The point of view and procedure are easily stated. The end—effective lighting—is not as easy to attain.

No, lighting, especially good lighting, is not quite as simple as some writers have so glibly stated. It is a complex problem in which director, technical director, scenic artist, lighting artist, electricians, and even actors are concerned, and a good solution of the problem requires harmony and co-operation among them. The best solution—the perfect solution—is like the will o' the wisp or the pot of gold at the foot of the rainbow. One can never quite catch up with it, but the fun is in striving for the ideal. Three well lighted interiors are shown in Figures 44, 45, and 47.

16. The Light Plot

The light plot is not to be confused with the electrician's or operator's cue sheet described below. The light plot is actually the result of the process which has just been outlined in this chapter.

The director or producer of a play may have in mind a certain effect or idea which he wants carried out in lighting. He may not know in terms of lighting units how to get it; so he gives his idea to the lighting artist or electrician, and one or the other works out the light plot after he has read the play and attended rehearsals to learn the stage business. These data which have been gathered and finally resolved into notes and diagrams of scenes like Figures 42 and 43, compose the light plot.

Ideally the scenery should be painted in the stage light which will be used in performance. This brings the stage designer into the lighting problem, and at times he may be more concerned in the light plot than usual. For example, a stage designer often wishes to use light as a part of his design for a scene (function b of Division II). In this case, it is he who conveys his idea to the lighting artist or electrician by means of sketches and explanations which are to be interpreted in terms of apparatus. Figure 46 is an example of light which is an essential part of the setting. The light plot, then, is the complete lighting plan of a play.

17. The Cue Sheet

The lighting cue sheet is usually the switchboard operator's guide, made from the text of the play and the light plot, which he follows during the performance. If there are operators

stationed in the balcony or other remote places to change the focus or direction of a spotlight or change a gelatine, these operators must have a cue sheet. If the switchboard operator's cues are very elaborate and if the changes in intensity and so forth have to be very carefully timed, a number of light rehearsals will be necessary, and the operator may need one or two assistants to help operate the switches and dimmers. If there are just one or two dress rehearsals of a play with elaborate light cues and there can be no light rehearsals, the cues can be written in the margin of the text, and one who knows the play well can direct the operator's movements in handling the lighting during the performance. Smooth lighting changes are absolutely necessary to the success of a performance, and an accurate cue sheet followed by an alert operator will be a vital element in a good performance.

18. Conclusion

In the example in this chapter, the lighting of a play in an interior box set, it is evident that light, shade, color, form, movement, and intensity (Ch. VI, and Ch. VII) must all be considered in designing the lighting for a play, and that different kinds of lighting units properly controlled (Ch. V) are necessary to bring this lighting design into visual reality. Furthermore, it is evident that some little knowledge, at least, of the elements of electricity (Ch. II) and of light (Ch. III) are necessary for the proper handling and operation of the lighting equipment. This information combined with experience will bring significant results—results, alas, not often seen in non-professional performances. These significant results will be lighting, subtle and unobtrusive, lighting which never cries out, lighting second only

to the play and the actors but which fits quietly into the *inscenierung,* as a unit in the whole.

Very often, as in this example, a moderate number of lighting units will be sufficient to accomplish all of the functions. Again a production may require an elaborate array of units and equipment. Occasionally, as in the latter part of the production of *Hippolytus,* (Ch. VII, Sect. 2) a single concentrated shaft of light striking across the stage produces selective visibility; it guides the eye to the center of interest, Hippolytus and his father; it suggests the last fading glow of sunset; and finally, it steals back in a narrow shaft to indicate the first rays of moonlight. As the shaft grows smaller and smaller, one forgets the other shadowy forms about the stage and sees only the faces of the two principals. The light is a definite element in stage design, and the psychological and emotional intent of the play is accomplished when the light dims out completely as Hippolytus breathes his last. Thus all of the functions of light are accomplished with a single source changing only in intensity and form.

It is evident, then, from the suggestions and remarks in the preceding chapters that stage lighting, as we know it, is capable of accomplishing the functions of general and specific illumination. These functions are somewhat arbitrary divisions, and in a measure they overlap; but the purpose of the division is merely that of separation, so that analyzing the material will be easier. It is platitudinous to say, but none the less true, that light can and will in the very near future do more in play production than present practice allows. Our apparatus is comparatively crude, and there are too few scientists and engineers interested in stage lighting. The theatre, also, is at fault in that it is bound by

many old conventions; it is slow in adapting and accepting what science and engineering have already done.

Nevertheless, an art of stage lighting is growing forth from the science of illumination, but for the present at least, the art is not ready to free itself from its origin. Of course, it is the end in which we are interested—the end which is not only the illusion of reality, but a selected æsthetic interpretation of reality. Yet, in our flight of creative imagination in the art of lighting, we must keep our feet on the ground of methods by which we can bring this vision into reality for an audience. The science is just as important as the art. Knowing lighting from two points of view, that of science and that of art, will lead one with creative imagination into the front rank of the new lighting artists—the artist-technicians of tomorrow.

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A Little Theatre Service

Cleon Throckmorton, Inc., 102 West 3rd St., New York.

NOTE: Mr. Throckmorton has established a Little Theatre Service in connection with his studios where the wants of the Little Theatre can be taken care of completely. Expert advice on entire productions is available here, and a complete buying service for any theatrical hardware, electrical supplies, properties and costumes is offered, no charge being made for this service.

Mr. Throckmorton has devised a number of unit settings that are well adapted to the special needs and limitations of the smaller theatres which find it impractical to build their own scenery or which wish to supplement their equipment.

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